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FISHES OBSERVED AT NICE, 1865.—THE CHIMÆRA AND THE ALEPOCEPHALUS.

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(With a Coloured Plate.)

COUCH, in his *History of the Fishes of the British Isles*, vol. i., p. 149, says of the *Chimère arctique*, Lacep., or *Chimæra monstrosa*, Linn., that "it is not the least remarkable portion of the history of this fish, that while its most chosen residence is in the depths of the Polar seas, it is also found in the Mediterranean, where it has been caught so frequently as to have received the familiar name of Cat from the fishermen of Nice. In explanation of this we can only suppose that in some former distribution of the temperature of our world, this fish inhabited other regions than those in which it is at present found; and that the extreme depths of the Mediterranean Sea continue to afford it all the requisite conveniences for life and propagation that are now also found, and more generally, in the more northern regions."

The species here referred to is occasionally caught at all periods of the year in the Bay of Nice, showing that in its deep marine valleys the fish finds a congenial place for its dwelling and propagation. It is called by Risso *Chimæra Mediterranea*, and it differs in so many particulars from the representation of the *C. arctiqua* in *Cuvier's Règne Animal*, as to appear to be a different species, so that the illustrations and description which I made in January last from fresh-caught specimens in the Bay of Nice may be useful to some of the readers of the INTELLECTUAL OBSERVER.

The specimen selected of the *Chimæra Mediterranea*, Risso, Fig. 1, is of a medium size, and measures from the end of the snout to the end of the tail thirty inches, but it is not unfre-

quently taken twice that length. The *body* is somewhat compressed on the sides, and gradually tapers from the head to the end of the long cord-like tail. The *skin* is very soft, smooth, pliant, and mucous, its colour a warm glaucous grey, shaded along the back with dark brown, and on the sides with paler brown shadings of a warmer tint; the abdomen and under part white, and covered over with very small silvery scales, and reflecting in certain light a very bright glaucous hue, glistening like silver. The *head* is large, thick, sloping from the top of the eyes with a slight curve into a soft, obtuse, rounded snout, which is cleft at the end, and underneath it, and near the centre of the eye, is the rather small *mouth*. The jaws are furnished with bony plates in the place of teeth—the upper jaw has two, broad, rounded at the inner angle, and behind them are two large, broadly triangular plates which form the roof of the mouth; the lower jaw is also furnished with two somewhat triangular-shaped plates, the front angles elevated into rounded lobe-like teeth opposite the upper ones, the sides are extended along the edge of the jaw, and entirely lining it with a hard polished plate, which is strengthened with thickened, elevated rounded bands, thus rendering them much more powerful instruments for crushing the food. *Eyes* large, placed high on the head, prominent, of an oblong shape; the *iris* silvery white, dotted with green points; the *pupil* large, prominent, of a glaucous green colour. From the top of the eye the neck ascends to the first dorsal fin, and from this the back descends in nearly a straight line to the tail. The *first* dorsal fin is placed opposite the pectoral fin, is of a triangular shape, having in front a long, solid, triangular-pointed spine, the angle in front of which is rounded, obtuse, smooth, but the two other angles are sharp-edged, and finely toothed, the teeth pointed downward. The fin is membranous, a greyish brown colour, the margin waved and blackish; the lower portion is united to the *second dorsal* fin, which is narrow, of the same width throughout, and extends the whole length of the back to the root of the caudal, terminating in a rounded lobe; it is of a pale brown colour, with a black margin. The *caudal* fin is of the same colour as the dorsal, but narrower, and extends on both sides of the tail, gradually becoming narrower until it is lost in the long pointed cord-like tail, which, from its root to the end, is about as long as the rest of the body. The *anal* fin is at the root of the caudal, small, blackish, fleshy, extended into a narrow lobe. The *ventral* fins are broad, elliptical, arising on each side of the vent about the middle of the body, they are thick and fleshy at the base, becoming membranous towards the margin, and of a dark brown colour; from the inner margin close to the body each of these fins has an oblong,

white fleshy clasper divided into two lobes at the point. The *pectoral fins* are large, oblong, obtusely pointed, thick and fleshy, with a large reddish disc at the base; the rest of the fin is membranous, and of a brownish grey colour. At the base of each of these fins is a narrow, longish opening to the gills, which is single, and not several, as in the sharks. The *lateral line* is elevated, pale, with a darker line on each side. It arises from a little beyond the back of the eyes, is curved up towards the first dorsal fin, but soon descends again, and is then continued in a nearly straight line to the end of the second dorsal fin, where it is curved down to the lower edge of the caudal fin, where the lateral lines of each side are united together, and from this point it is continued as one line along the slender tail. From the commencement of the lateral line at the back of the eye two other branches start, one to the top of the head, which soon becomes divided into two, one branch going over the head to join the lateral line on the opposite side, the other runs along the top of the eye to the snout; the other branch from the back of the eye takes a downward direction along the lower edge of the orbit, and takes a zigzag course over the cheeks to the snout, and becomes joined to one which is carried down the front of the snout; other branches are sent off to the gill openings and each of the lips: along the whole course of these lines it has numerous small round openings, which appear to be the ducts for the distribution of a secreted mucous.

The common name of *chat* (cat), by which this fish is known by the fishermen at Nice, was given to it from the noise like the mewing of a cat which it makes when taken out of the water. The flesh is white, soft, and glutinous, and has not an agreeable flavour, so that it is not used as an article of food, but it is caught for the very large liver with which it is furnished, and the limpid oil which they extract from it, which they burn in their lamps, as it gives a very brilliant light. It, however, has a disagreeable odour—a quality which the fishermen do not appear to think very objectionable. It has the reputation, like the oil extracted from the liver of some other fishes, of being a valuable remedy in the cure of rheumatism, especially when rubbed over the swollen and painful joints.

Fig. 1 is a lateral view of the entire fish.

Fig. 2, part of the skull, showing, *a*, the upper teeth; *b*, the lower teeth; *c*, the lower jaw; *d*, the upper jaw and orbit.

Another species, which inhabits the deep marine valleys of the Mediterranean, is the *Alepocephalus*, Risso. Its generic characters are—*body* ovate oblong, compressed, covered with

ovate scales; *snout* rounded, advanced; *jaws* and palate with very fine acute teeth; *gape* large; *eyes* very large; *gill covers* with eight rays; *dorsal fin* opposite to the *anal*, and both placed near the tail. Only one species is known, which is the

A. rostratus, Risso, commonly called *Alepocephale à bec*. The *body* is twelve to fourteen inches long, of an ovate oblong shape, the sides compressed, covered with large ovate oblong thin scales, marked with fine circular lines of a violet blue colour, and each scale clouded towards the end with minute brownish black dots. The head is of a medium size, covered with a black, glossy, membranous-like skin, which is very thin, naked, entirely without scales, and extended over the gill-covers, and forming the brachial membrane; the *eyes* are very large, prominent; the *iris* black; the *pupil* somewhat glaucous. The *forehead* slopes from the top of the head, and is curved in front of the eyes, and is then extended into a projecting rounded snout; the *upper jaw* longest, furnished on the margin with a single row of fine sharp-pointed teeth, except at a notch in front, and within is another row of similar teeth, on the edge of the palate; and into the groove formed between these two rows the edge of the *lower jaw* fits in, which is also armed with a row of teeth similar to those in the upper jaw. The sides of the jaw are wide, and the point terminates in an obtuse bony protuberance. The *tongue* is free, smooth, and, like the palate, lined with black. The *nostrils* are two on each side, in front of the eyes, the one nearest the eye much larger than the one in front of it. The *gill-covers* are extremely thin, long, angular below, roundly lobed at the back; the *brachial membrane* loose, furnished with eight slender rays. The *neck* is flattened, with a somewhat prominent osselet running its whole length. The *lateral line* arises from the top of the gill-covers, behind which it is curved down to near the middle of the body, and then continued in a straight line to the tail; it is formed of a series of short tubes on the middle of the scales along its course; and there are some of these tubes arranged beneath the lower jaw; they appear to be ducts for the conveyance and distribution of a mucous secretion over the surface of the body. The *fins* are of a blackish colour, covered at the base with scales; the *dorsal* is fixed far back, near to the tail, and has fourteen rays; and opposite to it, on the under side, is the *anal;* it is similar in shape to the dorsal, but extends rather nearer to the tail, and has fifteen rays. The *ventrals* are placed in the centre of the body, and have eight rays; the *pectorals* are near the edge of the gill-covers, and have eleven rays each; the *caudal*, which is large and strong, is somewhat half-moon shaped; it has thirty rays. The female, which resembles the male in its

general appearance, is full of brownish-coloured ova during the summer months.

The Chimæra and Alepocephalus are good examples of those fishes which inhabit the deeper parts of the sea—that is, from two to three thousand feet; and how much deeper than this any kind of vertebral fishes are capable of living is very doubtful. And of those fishes which are known to live in very deep water, it may be observed that their eyes are disproportionately large and prominent—an adaptation of the organs of sight made by the all-wise Creator, by which the creatures are enabled more effectually to collect the diminished power of the rays of light at so great a depth of water, and are thus made capable of seeking their food and the enjoyment of life in their appointed abode. The skin, too, is thin and soft, and the scales loosely adherent, and the colours with which they are adorned are far less brilliant, more clouded, and their marking is not as distinctly defined as in those fishes which inhabit the shallower parts of the ocean, where the sea-weeds and corals, etc., abound, and where the power of the sun's illuminating rays are more potent, as is found to be the case in the Julia, the Labias, the Crenila bras, etc. The flesh of these deep-sea fishes is also softer, more gelatinous, and much sooner decomposes after death, than that of most other fishes.

The difference in the structure of these two fishes is very remarkable, and worthy the attentive consideration of the student of nature's works. The Chimæra, with its obtuse, fleshy snout, has its mouth placed underneath and behind it, and the slit-like opening to the gills before the pectoral fins allies it to the shark tribe, and its peculiar shaped head, bony, plate-like teeth and palate, shows that its food is that of some hard substance, or it would not be furnished with such powerful organs to crush it; and we find that it lives on crustaceous or molluscous animals, that have hard shells or bony coverings. The Alepocephalus has the ordinary form of abdominal fishes, and its mouth is furnished with rows of small, fine, slender, pointed teeth, showing that its food is of a soft substance, and which is not protected by any hard or bony covering.

THE WINDS.

BY A. S. HERSCHEL, B.A.

In a recent pamphlet, by Dr. Klein, on Foretelling the Weather, translated from the Dutch by Dr. Adriani, the atmosphere is described as being the means of keeping up upon the earth the salutary movement which it constantly requires. The office of the atmosphere by which the various forms of life upon the earth are supported, and conveyed to distant places to renovate its surface, is performed in part by a steady process of distillation, and in part by the perpetual agitation of the winds. The constant round of functions it fulfils will accordingly well repay attention to examine very closely in detail. For present purposes the atmosphere must first be regarded as a vast cryophorus, or as an immense distilling apparatus, having its boiler on the surface of the earth, and its condenser at the summit of the atmosphere. The vertical process of evaporation and condensation into rain can then be fitly described, which everywhere takes place in a tranquil atmosphere, in the absence of the horizontal currents of the winds.

Over the greater part of the equator, and especially on the ocean, where the air is calm, clouds are seen to gather in the morning, which collect before the evening, and break with heavy showers of rain. A fall of two or three inches of rain in as many hours is no uncommon occurrence in those regions; whence the name of "cloud-ring" is applied to these parts of the equator. Wherever under the full heat of the sun the wind subsides, a cloudy season similar to that at the equator commences. In certain places between the tropics, the regular winds are thus suspended when the sun approaches the zenith of the latitude, and a season of "tropical rains," as they are called, immediately sets in. This happens in April on the Orinoco, in May or June at Sierra Leone and Calcutta; falling later in the year at each place according to its distance from the line. On the opposite side of the equator the island of Mauritius, situated on the outer border of the trades, is visited in February by heavy rains; which is also there the hottest season of the year. The rice fields in the valley of the Ticino, in Lombardy, owe their fertility to the tropical rains which fall in summer on its sheltered plains. A part of the European and Asiatic continents, and a part of central America, are described in a less marked degree as districts of "summer rains." This remark is illustrated by the fact, familiar to readers of the Intellectual Observer, that at the mouth of the Danube, in the summer of last year, the rains were noticed to be "quite tropical" in their extent and character.

Supposing, now, the boiler of the cryophorus to be at the equator, and its condenser at the poles, a distribution of rain in a horizontal direction from the equator would take place. But the winds alternately carry moisture outwards from the equator, and act as condensers returning from the poles; and the process of lateral condensation is also modified by elevated mountain ridges and irregularities of the land. Upon the south-west coasts of Europe, autumn rains are abundant, occurring with the season of the south-west wind. The effect of mountain ranges in arresting moisture, is illustrated by the enormous quantities of rain which fall at Coimbra, Borrowdale, and Bergen, on the coast: whilst Madrid, surrounded by high mountains on the table-land of Castile, has a rainfall of only ten inches in the year. At Lyndon, in the centre of England, the rainfall is below the average. Only flower seeds can be cultivated in some parts of the British Islands, on account of the deficiency of moisture; but at Seathwaite in Cumberland, at Toronsay in the Isle of Mull, and at Portree in the Isle of Skye, the fall of rain is more than 100 inches annually. Other examples, to illustrate the effect of mountain ranges in precipitating the moisture of the wind, will be borrowed from tropical climates, in describing the winds of those climates, called monsoons.

In the highest regions of the atmosphere, where condensation constantly takes place, moisture is deposited in the solid form, and accumulates from year to year, as snow, on mountain tops, even at the hottest parts of the equator. Large masses detaching themselves from its sides, rush down the steeps in avalanches; but water melted from the surface by the sun, converts a large portion of the interior into ice. Glaciers are thus formed, whose ponderous masses slowly descend the ravines, until they melt away below in torrents that water innumerable valleys. Above the height where the mean temperature of summer is the same as the freezing-point of water, there is a perpetual surface of fresh fallen snow. Below this point, the glaciers and mountain slopes, in summer, are free from snow. The level in question is called the "snow-line," or level of perpetual snow.

The following table of the measured height of the snow-line in widely different latitudes, from a list of places contained in Humboldt's work on *Central Asia*, enables us to calculate the decrement of temperature, in ascending, from the mean heat of summer on the plains, to a temperature of 32° (F.) at the height of perpetual snow. The corresponding decrements for equal elevations, determined by Mr. Glaisher in his recent balloon experiments, when the sky was clear, are next entered in the table for comparison.

TABLE V.—Height of the snow-line above the sea, and mean temperature of summer in the plains, from Humboldt's *Central Asia*.

Place.	Mean summer temperature at sea level.	Measured height of the snow-line above the sea.	Decrease of temperature.	The same (from Mr. Glaisher's balloon experiments).	Difference.
	° (Fah.)	feet	° (Fah.)	° (Fah.)	° (Fah.)
Quito	83·5	15,900	51·5	45·8	—5·7
Himalayas (S. Side)	73·4	13,056	46·4	40·2	—6·2
Mt. Ararat	78·1	14,250	46·1	42·5	—3·6
The Alps	65·1	8,937	33·1	31·0	—2·1
Kamschatka	54·7	5,280	22·7	21·6	—1·1
Isle Mageröe (N. Cape)	44·5	2,286	12·5	11·9	—0·6

The regular progression noticed in the last column of differences, appears to show that the heat of summer on the plains fairly determines the elevation of the snow-line, but the decrement of temperature with the height near the equator appears to be more rapid than that found in the experiments of Mr. Glaisher.

No better description can be given of the ventilating system of the atmosphere, than that which is contained in Sir John Herschel's work on Meteorology, from whom we borrow the following exposition of the process (*Meteorology*, p. 54):—

"In the intertropical seas a steady and copious evaporation is continually going on. The vapour, carrying with it air, is thrown up beyond the levels of equilibrium, where it flows over, and spreads itself out over the upper regions of higher latitudes. Air also, when heated over large tracts, acts by increased elasticity to upheave the superincumbent strata, and by bulging them upwards to destroy their equilibrium, and cause the upper atmosphere to flow over on less heated regions. It is impossible to separate these two dynamical effects. The immediate effect of the application of heat to any region, is to generate an ascensional movement in the incumbent atmosphere: a bodily overflowing of its material above, and a relief of barometric pressure below."

In the Atlantic Ocean, from the equator to 5° N. latitude, the atmospheric pressure is 29·92 inches. From 30° to 35° N. latitude it is 30·17 inches, and from 25° to 30° S. latitude it is 30·11 inches; making the relief of barometric pressure 0·22, or

nearly a quarter of an inch between the equator and the tropics in this part of the ocean.

A further account of the origin and nature of the great ventilating system is given by Sir John Herschel in the same work from which the former paragraph was borrowed (*Meteorology*, p. 56):—

"The air of the cooler surrounding region not being so relieved (by overflow), but rather the contrary, owing to the increase of weight poured on it from above, will be driven in by the difference of hydrostatic pressure so arising; and thus originate two distinct winds, an upward one, setting *outward* from the heated region, a lower, *inward*. If the region heated be a whole zone of the globe, such as the generally heated intertropical region, these currents will assume the character of two sheets of air setting inwards on both sides below, uniting and flowing vertically upwards along the medial line, and again separating aloft, and taking on a reversed movement."

The upper and lower currents, from what was said in the former article on their stratiform character and horizontal extension, remain distinct, and travel separately over a tract of many degrees from the equator. The direction of the upper current may be inferred from the following remarks of Redfield, whose opinion on the subject of aërial currents must always be regarded as of the greatest value:—

"We learn from Humboldt that in the great eruption of Jorullo, a volcano of southern Mexico which is 2100 feet above the sea, the roofs of the houses in Queretano, more than 950 miles N., 37° E. from the volcano, were covered with the volcanic dust. In January, 1835, an eruption took place in the volcano of Cosequina, on the Pacific coast of Central America, having an elevation of 3800 feet above the sea, the ashes from which fell on the island of Jamaica, distant 730 miles N., 60° E. from the volcano. The ashes of the volcano of St. Vincent fell at Barbadoes in 1812, a distance of 120 miles nearly due east from the volcano."

The direction of the upper current is therefore very oblique to the meridian, and directed from south-west towards north-east. The cause of this deviation now remains to be explained.

Were the earth at rest, and did the sun actually revolve about it as it appears to do, the main currents of the air produced at the equator would everywhere follow the course of the meridians, and no deviation would occur. But an appeal to experiment will readily show that a deviation of exactly the kind observed is really caused by the rotation of the earth.

Suppose a whitened globe to be suspended by one of its poles; in such a manner that it can be turned from east to west,

to represent the daily revolution of the earth. A circular rim pierced with holes is fastened to the globe, about its upper pole; and a few streams of ink are allowed to run from these upon its surface, whilst the globe revolves. In a few seconds the globe can be brought to rest, and the direction of the streams can be examined. Each stream presents a curvilinear line; in general very oblique to the meridians, but at its centre transverse to the equator, to which its upper and lower branches are also symmetrical, and turned towards the east in the manner of a Greek letter ϵ. This simple experiment may very well be taken to represent the real course of nature. The streams in the upper half of the globe represent the trade winds, which blow from the north-east in the northern hemisphere, and from the south-east in the southern hemisphere of the globe. At the equator they are exactly opposed to one another, and blow due north and south, where the belt of the "variables" is formed, as they are called, because they are mixed at this place with westerly monsoons. The streams in the lower half of the globe represent the anti-trade winds. These return upon the same course as the trade winds, but in the opposite direction to the point whence those set out, and blow from south-west in the northern hemisphere, and from north-west in the southern hemisphere of the earth.

The anti-trade wind blows in summer upon the top of the Peak of Teneriffe, while the trade wind sweeps its foot. In winter the anti-trade wind reaches the ground about the latitude of the Canary Isles, and in its contest with the trade winds forms the "horse-latitudes" of the ocean, with rains as copious as those at the equatorial calms. From this point to the latitude of 50°, and upwards, the anti-trade is the prevailing wind of the Atlantic Ocean, almost as surely as the trades between the tropics. These winds are only constant on the open oceans of the globe, for a reason that is easily explained. In the neighbourhood of continents they are replaced by winds of a different character, called monsoons.

The constant overflow, and demand of air at the equator produces an equally regular supply, flowing north and south towards the line. Obedient to the impulse of the wind, a drift of surface-water inwards is produced, and a line of greatest heat is thus established at the equator, whose position hardly varies with the seasons. In this way the trade and anti-trade winds acquire a cast, or set by which the uniformity of their circulation is secured.

Coming from latitudes where the velocity of rotation of the earth's surface is less swift, light air currents quickly take up the velocity of rotation of the circles of latitude over which they pass. It is different with the surface drift of water.

This, from its greater weight, preserves a relatively sluggish motion up to the equator. A "main equatorial current" is thus produced in the Atlantic Ocean, flowing with a velocity of from two to four miles an hour towards the west (with various branches towards the north and south), and finally losing itself in the Carribean Sea. The level of the Gulf of Mexico is thereby raised, and a stream of water, without a parallel for magnitude and velocity, flows from this gulf through the narrow Straits of Florida. Where it enters the Atlantic Ocean, the Gulf Stream, as it is called, is thirty-two miles in width, two or three hundred fathoms deep, and its average velocity is about five miles an hour. Its temperature is 83° Fahrenheit.

Off Cape Hatteras the Gulf Stream leaves the American coast; and spreading itself over the Atlantic Ocean, in two or three months it attains the longitude of the Azores. Beyond this point, at all seasons in ordinary years, and in every direction in the great ocean-space comprised between the Azores and the coasts of Europe and Western Africa, the sea is of the ordinary temperature for its latitude, and the warm water of the Gulf Stream is not found. But Major Rennell has shown that on two occasions—namely, in 1776, as observed by Dr. Franklin, and in the winter of 1821-2,— the warm water which characterizes the Gulf Stream was found to extend across this great expanse of ocean. In November and December, 1822, and January, 1822, the weather in the south of England and in France was characterized as most extraordinarily hot, damp, stormy, and oppressive. The gales from W. and S.W. were almost without intermission, the fall of rain was excessive, and the barometer was lower than it had ever been known for thirty-five years before. If an unusual velocity at its outset, or a greater height than usual of the water at the head of the stream, causes these invasions of the Gulf Stream, these might be recognized by proper attention. As they must precede by many weeks the arrival of the warm water on the coasts of Europe (more than 3000 miles from its source), in this manner the climatic effects arising from this stream, and the occurrence of such unusual seasons upon our coasts as that of 1821-2, might probably be anticipated.

On land, where no such movement as that upon the surface of the ocean can exist, the focus of greatest heat follows the motion of the sun once in every year to either tropic. The annually alternating winds that arise in this manner are called "monsoons."

TABLE VI.—Mean Annual oscillation of the barometer at Greenwich, above and below par height, for nineteen years (1840—58).

	in.		in.		in.
Jan.	— 0·031	May	— 0·029	Sep.	+ 0·056
Feb.	+ 0·012	June	+ 0·017	Oct.	— 0·077
Mar.	+ 0·060	July	+ 0·013	Nov.	— 0·037
April	— 0·030	Aug.	+ 0·010	Dec.	+ 0·036

The mean height of the barometer at Greenwich, from 1840 to 1858, was 29·782 inches, or reduced to the level of the sea, 29·953 inches. The mean annual oscillation above and below this height was very small, and irregularly distributed in the year. A settled condition of the barometer is not only observed in Western Europe and Africa, but also over the greater part of the Mediterranean Sea. Over the whole continent of Asia, in the east of Europe, in Arabia, Nubia, and part of Central Africa, a very remarkable depression of the barometer takes place in summer. A lack of aqueous vapour in summer, to supply the sudden overflow of heated air, evidently occasions the barometric depression over this wide area, which embraces the most arid plains and the highest table-land of the world. At the same time, the barometer in the southern hemisphere is high (although the pressure of aqueous vapour is least), showing that air is actually transported to that quarter in a bodily shape. In winter the barometer in Asia is high, whilst the barometer in the southern hemisphere is low, showing that an influx takes place in the opposite direction. These oscillations of the barometer, lately shown to exist by Dové of Berlin, explain the origin of the monsoons upon the Indian Ocean.

In the same manner that a barometrical depression, and consequent circulation of the air are permanently produced upon the ocean by the sun's heat, an annual overflow of air from the continent of Asia takes place in summer, accompanied by currents flowing inward below, outward above, to and from the heated region as a centre. In winter, when the barometer is low over the southern continents of Africa and Australia, and high over Asia, the conditions are reversed, and the currents then flow in an opposite direction.

From the great stretch of land (nearly a quarter of the northern tropic) by which the Indian Ocean is barricaded on the north, the impulse of the Asiatic monsoons is alternately due north and south. Owing, however, to the diurnal rotation of the earth they deviate from this direction towards the east and west—like the trade and anti-trade winds—and are called from this circumstance the north-east and south-west monsoons.

The south-west monsoon makes its first appearance in April on the coast of Malabar: with a rainfall of 80 to 170 inches,

between April and October, upon the range of the West Ghauts, and thick weather extending to fifty miles from shore. At sea it is a rainless wind. This monsoon stretches across the whole Northern Indian Ocean, from Africa to the Malay Peninsula, originating 3° to 4° north of the line, at the northern edge of the "Doldrums," or equatorial calms, which separate it by a belt of 10° or 12° from the south-east trade. The south-west monsoon sweeps the Arabian Sea, and traverses the rainless district of the Indus. It also enters the Bay of Bengal, and produces a heavy fall of rain upon the mountainous coast of Aracan. Farther east it scours the China Sea to its limit in the Philippine Islands, the outposts of the Pacific. In this extensive range the period of its commencement at different places is April, May, or June, according to their remoteness from the equator. Probably no greater rains are caused by this monsoon, or indeed by any other wind on the earth, than those which fall at Cherra-Ponjee in the north-east hills of India, where 592 inches of rain are said to be collected annually. Two or three hundred inches are no uncommon quantity in other parts of the Himalayan range, during the season of this monsoon. The general aridity of Central Asia is thus in a striking manner accounted for.

The north-east monsoon commences in October, and occupies until April the whole of the tract vacated by the opposite monsoon. A monthly fall of fifteen to twenty inches of rain, with this wind, on the coast of Coromandel, appears to be caused by its condensing action on the upper current, when upheaved by the elevations of the coast. Like the other monsoon, it is itself a rainless wind.

The north-east monsoon crosses the equator at two points, one near the channel of Mozambique, which it enters; the other towards the Java Seas, which it traverses as far as New Guinea and Timor. In these lesser districts the south-east trade wind is replaced by a north-west monsoon (corresponding to the anti-trade wind of that hemisphere), occasioned by barometric depressions over the heated continents of South Africa and New South Wales. On the western coast of Mexico, also, the north-east trade in summer is similarly reversed by a south-west monsoon; but the most remarkable monsoons are those of the equator on either side of the great continent of Africa. These two monsoons are westerly, and occupy what is commonly called the calm belt of the equator. They fall at opposite seasons of the year. The first, or "Westerly Line Monsoon," occupies the Atlantic side from July to October. The other, called the "Winter Monsoon," occurs in the "Doldrums" of the Indian Ocean, and occupies the remaining season of the year. In the words of Maury, "these

winds are a study, and suggestive of marked peculiarities in the climatology of equatorial Africa."

The trade winds are the permanent, monsoons are the annual, and land and sea breezes are the diurnal features of the general system of the winds. The last are caused by the daily depression of the barometer, which is most conspicuous at the equator. Humboldt, when at Cumana in 1799, affirmed that the hour of the day might be known correctly within fifteen minutes, by the rise and fall of the quicksilver in his barometer, which amounted to nearly the tenth part of an inch daily. In other latitudes, the oscillation, although easily traced, is smaller, and concealed by greater irregular movements of the mercurial column. The following table contains the average value of this oscillation, from bi-hourly observations at Greenwich for five years, 1841-45.

TABLE VII.—Mean Diurnal oscillation of the barometer at Greenwich, above and below mean height of the barometer, for five years (1841-45):—

	In.		In.		In.
1 h. a.m.	— 0·002	9 h. a.m.	+ 0·009	5 h. p.m.	— 0·008
3 h. „	— 0·010	11 h. „	+ 0·011	7 h. „	— 0·000
5 h. „	— 0·012	1 h. p.m.	+ 0·001	9 h. „	+ 0·009
7 h. „	— 0·003	3 h. „	— 0·007	11 h. „	+ 0·009

The course of the numbers shows that the barometer stands higher by day than at night, owing to the generation of aqueous vapour. Its lowest minimum is reached about the coldest time in the morning, when the quantity of aqueous vapour is least. Another minimum occurs about the hottest hour of the day, when the heat of the sun causes a portion of the air to flow off from the top of the atmosphere. This minimum is less considerable than the great minimum observed at night.

The existence and character of this oscillation were known from the earliest use of the barometer, and are everywhere the same, wherever the alternation of day and night occurs. The extent and nature of the annual oscillation, on the other hand, depends upon local circumstances, particularly on the distribution of land and sea. For other and larger oscillations which return at stated periods no cause whatever can be assigned. It is observed, for example, that about the middle of November a wave of high barometric pressure passes over England, and another about the 25th of December. In this interval the barometer reaches a very low point about the 28th of November. To trace the motion of these atmospheric waves, the ocean has been divided into squares, each numbering ten degrees of latitude and longitude. A permanent depression of the barometer to the extent of fully an inch was

discovered by Sir James C. Ross, about the longitude of Greenwich, upon the confines of the Antarctic Sea. Another region of great permanent depression, near the Sea of Ochotzk, is known to exist at a diametrically opposite point upon the earth. If these observations should be confirmed, there can be little doubt that a cyclonic tendency of the wind round these regions must exist as a permanent feature of atmospheric circulation. May not these two regions of depression be the true Atmospheric Poles of the world; and may not the vortices which they appear to indicate furnish an answer to the question, "What becomes of the anti-trade currents of the air returned to polar regions from the equator?"

The velocity and direction of wind may be registered either in words or in a scale of figures, velocities, or pressures, as in the following table:—

TABLE VIII.—Wind-scales, or scales of the force of wind.

General term.	Land scale.	Sea scale.	Velocity. Miles per hour.	Pressure. lbs. on one sq. ft.
Calm	0	0	0	0
Light	1	3	10	½
Moderate . . .	2	5	32	5
Fresh	3	7	45	10
Strong	4	8	65	21
Heavy	5	10	72	26
Violent	6	12	80	32

Instruments for recording the force and direction of wind are called anemometers (*ἄνεμος, wind*; *μέτρον, a measure*). In Robinson's anemometer the distance run over by the wind is shown by four hollow cups attached to multiplying wheels, whence the number of revolutions can be read off upon a dial. A simple calculation then gives the velocity of the wind. The pressure of the wind on a plate of one square foot is proportional to the square of the velocity. It is recorded by means of springs, in Osler's anemometer, upon a moving sheet of paper, whilst a large vane records on the same sheet the direction of the wind. This instrument, by an ingenious contrivance, records automatically upon the same sheet of paper the depth of rainfall for any time. It has been erected at Plymouth, Greenwich, and Birmingham, as well as at Halifax and the Bermudas on the Atlantic, to register the force and direction of the wind.

On the average of twenty years at Greenwich, thirty-three days in every year are calm, when no pressures greater than ¼lb. are recorded. On thirty-two days the wind is above moderate, and the pressures exceed 5 lb. The remaining three hundred days of the year are occupied by moderate or gentle winds. Of these gentle winds the largest share falls to the summer months, in each of which the occurrence of a fresh wind is an even chance; but *not one single January* without fresh wind has occurred for twenty years. Strong and moderate winds alike are far most frequent from south-west, where the wind lies for about a third part of the whole year (119 days). North-east is the next most frequent point, and from E., S.E., and N.W., the winds are the rarest of the dial.

A change of the wind from S.W. to N.E. produces nearly as great an alteration of temperature and moisture in the air as a change from day to night. The weight and density of the air are at the same time greatly increased, and the barometer (whose other oscillations are extremely small) becomes a valuable index of the reversed conditions of the weather. Professor Dové has shown that the change of wind from one of these directions to the other is subject to a curious law arising from the rotation of the earth. No law in meteorology is more easily verified, or better stands the test of daily observations than this, which is called Dové's "Law of gyration of the Wind."

Suppose a north wind to arise, by a body of air commencing to move towards the equator; in a short time it will become north-*east* in the same manner as if it formed a portion of the constant trades. Should the indraught be replaced by an impulse outwards from the equator, the northerly element of motion is destroyed, and that from the east alone remains. The wind therefore veers towards the east and south, and at length becomes south-*west* in the same manner as if it formed a portion of the constant *anti*-trade. Should an indraught towards the equator once more return, the southerly element of motion is destroyed, and that from the west alone remains. The wind then veers towards the west and north to the point from which it originally set out. At every alternate impulse north and south, the wind veers half round the dial *in the same direction as the sun*. In the southern hemisphere the same mode of reasoning leads to the same conclusion, or, in other words, in both hemispheres, the wind, in its ordinary changes, veers round the dial in the same direction as the sun. When wind shifts round the dial in an opposite or retrograde direction, it is said to "back."

In this manner the vane of Osler's anemometer at Greenwich, in twenty years, has performed two hundred and forty-

eight more complete revolutions in one direction than it has in the other.

Enough has been said in this article to explain, in a general manner, the nature and office of the winds. A few words on premonitory signs will show by what appearances, and to what extent (apart from instruments), their arrival may often be predicted.

South-west gales reach the British Isles from warm and moist regions of the Atlantic, in the direction of the Azores. They shelve upwards by their levity as they approach, and the phases of the advancing current can be traced by the growing streaks of cirrus in the upper air. The wind, at first in the north-east, veers very slowly through the east towards the south, and the blue curtain of the sky appears lined with bands of cirro-stratus cloud, stretching from horizon to horizon across the direction of the upper wind. Halos of every form, and a narrow border of light surrounding the moon, are a symptom of this condition of the wind. If these signs are remarkable for brightness or extent, and the clouds thicken, they take the form of *cirro-cumulus*, or a "mackerel-backed" sky, and are followed by severe falls of rain, hail, or snow, on the arrival of the wind.

North-east gales arrive upon the British coasts from colder climates, and from their greater gravity creep along the ground. Driving off the warmer air, they at first create dense clouds, or, contending with a southerly current, lightning, rain, and snow are produced, and the wind, at first south-west, veers rapidly through west towards the north. When the northerly current is established, fine weather reappears. Coronas, or highly-coloured circles round the moon in ragged clouds that scud before a north-west wind, indicate a liability of this wind to "back," and for the same order to begin again.

Lightning is always caused by the sudden condensation of vapour into rain; and the more rapid this process, the more severe is the lightning. Hail occurs in sultry weather, when aqueous vapour reaches a great height, and becomes entangled in currents of low temperature. That these storms in the upper air are often of a violent character may be inferred from what is related by Olmsted in America, Buist at Bombay, and Neumayer at Melbourne, in South Australia, that hailstones as large as pigeon's eggs are of annual occurrence.

With hail, as with rain, the tension of electricity on the surface increases in the exact ratio of the diameter of the drop. The present year was distinguished by two instances of hailstones of extraordinary dimensions, accompanied by very destructive lightning, at Liverpool and at Birmingham, on the 21st of May and 8th of July. One of the greatest falls of hail, since the

extensive hailstorm which passed over France and the Netherlands on the 13th of July, 1788, took place in the valley of the Scheldt on the evening of the 7th of May, and was followed by a fearfully destructive storm of lightning and thunder on the night of the following day over France and the Channel Islands, and over the southern coasts of England. The hailstones in this instance formed a perfect glacier, and canals in the Netherlands could be crossed dry-foot.

The aurora borealis, or northern lights, are occasionally supposed to have a distinct connection with the weather; but it has been shown (contrary to this hypothesis) by Professor Loomis that every display of aurora in the north is accompanied by a simultaneous display of aurora in the southern hemisphere of the earth, which is contrary to the supposition. Fiery meteors, also, are called "wind-headings" by the fishermen upon our coasts. That these are of astronomical character there cannot be a doubt, from their annual appearance in unusual numbers on the 9th—11th of August, and again on the 12th—14th of November.

For those astro-meteorologists who trace the signs of the weather in the stars, an example of coincidence without connection is presented in the following table of the dates when remarkable displays of the November meteors have been observed, compared with those in which, according to Arago, severe winters were felt upon the Mediterranean coasts of Europe.

Table IX.—Dates of the November shower of meteors, and of severe winters, arranged for comparison in groups:—

1. Dates of meteors.

A.D. 902, 1002, 1101, 1202, 1602, 1698, 1799 (Mean - - - 1)
A.D. 931, 1533, 1832, 1833 . . . . . (Mean - - 32)
A.D. 1366 . . . . . (Mean - - 66)

2. Dates of severe winters.

A.D. 1290, 1301, 1302, 1517, 1594, 1709, 1812 (Mean - - - 4)
A.D. 1133, 1236, 1336, 1544, 1839 . . . . (Mean - - 37)
A.D. 860, 1274, 1463, 1468, 1570, 1756 . . (Mean - - 65)

A period of the third part of a century appears to represent the return of the meteoric shower with precision. Allowing for meteorological contingencies, the same period appears to exist in the return of severe frosts. The coincidence is apparently complete; only the connection is by no means evident.

The present time may, accordingly, be regarded with probable foundation as a season of severe winters in the South of Europe. The extraordinary shower of meteors may be ex-

pected with greater certainty to return in full splendour in the present year, and the next, when observers will probably be repaid by watching for its appearance from midnight until daybreak on the morning of the second Monday in November, and again on the morning of the 13th of November, 1866.

A BRIEF HISTORY OF A MARINE TANK.

BY SHIRLEY HIBBERD.

In the "Brief History of a River Tank," published in February last (Intellectual Observer, vii., p. 38), I stated, as explicitly as I could, the principal features and advantages of the natural system of tank management, in order to present an illustration in the case of a tank so managed, and which was then, and still is, in the most perfect condition, and a familiar object with a large circle of friends. In my *sanctum* I have a marine tank which is fitted and managed on the same plan, and I propose to offer a few observations on this and some other vessels which have been used for marine collections.

When engaged in the experiments which were the foundation of my first written essays on the aquarium twelve years ago, and subsequently of the *Book of the Aquarium*, and some scattered papers in periodicals, the grand difficulty was to determine an exact and self-sustaining balance between the various forces and influences that an aquarium brings into play. Every failure then occurring was the result of attempting too much, and of absolutely doing too much; and looking back through all the experiences since acquired, I can say without a blush that the original notions entertained by aquarium practitioners were supremely ridiculous. Shall I ever forget the waste of precious time, and strength, and money in attempts to domesticate the larger forms of marine algæ? Shall I ever forget the sanguine wishes that were entertained of the successful cultivation of *Padina pavonia*, *Laminaria phyllitidis*, *Delesseria sanguinea*, *Ptilota plumosa*, and the lovely *Griffithsia setacea*, and how those hopes only faded out when years of watchfulness and wasted energy made it but too evident that it was easier to dream than to do? No, I shall never forget that the one great lesson that had to be learnt, and which needs to be repeated here, is that small quantities of sea water enclosed in vessels in dwelling-houses, are too peculiarly circumstanced to be made representative of Neptune's watery

kingdom, but they may be made representative of rockpools and recesses. We may treat them as spoonfuls of water, and achieve such success as spoonfuls admit of; but we must not suppose we have the sea at our command, and a choice for our amusement of all its vegetable and animal denizens. Yet, strange to say, all the early experiments proceeded on the assumption that a tank is a miniature ocean. Now the ocean somewhere is deep, and so, accordingly, the tanks were at first made deep, and that was the greatest of all the blunders that then abounded in the incipient realm of aquarian practice. After hecatombs of victims had been offered up, it was found that shallow tanks answered better than deep ones. I had the good fortune to call attention to the importance of shallow tanks and subdued daylight in the *Book of the Aquarium*, in time to contribute to that consolidation of aquarian principles which has resulted in the establishment of extensive tidal aquaria at the gardens of the Zoological Society of London, the Société d'Acclimatization at Paris, and the still more important and successful Aquaria at Berlin. It cannot be profitless to note the several points that have been successively demonstrated and established, because many persons are commencing the study of marine zoology, and need a little help from those who have had experience, and because, also, many who have had aquaria in their keeping for a series of years have not yet fully availed themselves of all the knowledge that has been accumulated on the subject.

Deep tanks are deep delusions. If it were possible to be content with a mere film of water over the animals they would, as a rule, prosper better than in depth enough to be completely submerged. The grand object is to present to the influence of the atmosphere the greatest possible extent of surface, and in shallow tanks this is of course accomplished. The slope-back tank is a heavy and rather cumbrous vehicle, and FOR THAT REASON it surpasses every other form where it is not possible to establish a tidal arrangement. The great mass of slate is not quickly influenced by changes of temperature, and the slope affords a great extent of rocky bottom for a picturesque disposition of the interior, and for the full growth of oxygen-making vegetation. This form also allows of the transmission of light in a subdued form, and an excess of light is impossible. Lastly, if the creatures confined in the vessel are of a roving habit, this propensity is encouraged, and wherever they roam they still remain visible.

Setting aside the notion of forming a complete submarine garden and zoological collection, let us consider the case somewhat in detail. The tank contains but a small bulk of water,

and this cannot easily be renewed in the event of its becoming foul. The largest tank ever made, and the largest series of tanks ever made, are but as drops as compared with the ocean, and the physiological and chemical phenomena taking place within them are on the same small scale as the tanks themselves. For instance, in place of the rush of the tide with its crest of foam and grinding of pebbles in a rock-pool, giving life and energy and abundance of food to the creatures that the pool shelters, in the tank there is of necessity a death-like stillness. This stillness reduces the capacity of the water for sustaining animal life, it is antagonistic to the generation of oxygen within or its absorption from the atmosphere. The algæ that grow in rock clefts and among littoral deposits are fully exposed to solar light, and are sometimes laid bare for hours to a burning sun. I know of many lovely meadows of Ulva and Enteromorpha, but principally the former, which are daily almost as dry at low tide as the hot sands above the water-line. We dare not imitate this feature in tank management. Sunshine makes our small pools opaque and viscid with an extravagant growth of superfluous vegetation, and as to laying the shoal dry daily it is out of the question, except it may for some unhappy individual who has nothing else to do than to pump or dip, and sell himself soul and body to a boxful of worms and periwinkles. If we keep marine animals at all, it must be by simpler methods than these. Lastly, to avoid tediousness, the animals we imprison are imprisoned; in other words, they do not select the site for themselves as when free, and with the immeasurable floor of the ocean for their playground; nor once consigned to the slate prison can they shift their quarters, even if, as *may* be the case, those quarters are not exactly to their liking. Seeing that in this brief view of a few of the details of the case, there are many difficulties to be encountered, it is a matter for gratulation and perhaps for pride, that so much has been done to enlarge the boundaries of our knowledge of the life that abounds in the deep sea.

Having fitted up and tended tanks innumerable, I always found that the best "weeds" for ordinary purposes were *Ulva latissima* and *Enteromorpha compressa*. I have made some practical notes on other forms of algæ in the *Book of the Aquarium*, and have no intention now to repeat myself. I found, moreover, that the best of all materials for rockwork was mica-schist, because on this there soon occurred a spontaneous growth of microscopic algæ and confervæ, which is the best grow[illegible] of five *A. mes[illegible]* keeping the tank in g[illegible] *bellis*, four [illegible] arrangements there was a certa[illegible] was also [illegible] wanted, and the object of fitting up the tank, of which a

description follows, was to endeavour to discover a way of making a marine tank take care of itself, and which must of course wholly depend upon the arrangements made in the first instance.

On the 24th of June, 1862, I fitted up a Warrington slope-back tank in my study. It was placed with its back to the window and at about fifteen inches from the glass, so as to receive but a moderate amount of daylight, and that wholly through the glass cover; light from the front being impossible. The tank is made wholly of slate, except the front, which is plate glass, and the back is placed at an angle of 40, which leaves a hollow cavity at the back; there is therefore no water chamber. The capacity of the tank is twenty gallons. Previous to fitting this tank I had by me a considerable quantity of *débris* from former experiments, and I set out in the full sun a large collection of old shells of oysters, whelks, serpulæ, and other odd gatherings that had lost their interest because their inmates had perished. Conspicuous amongst these were some pieces of tile and rock thickly coated with acorn barnacles. Fearing there might be some gelatinous matter, the result of deposition when the animals perished, I placed them in a vessel of water for a few days to dissolve out any organic detritus, and then placed them in the sun to be thoroughly sweetened. These several materials were used for covering the sloping slate back of the tank, and their adoption was a most decided gain; in fact, they soon told me that heavy blocks of mica-schist or *any other rock* were wholly unnecessary. These slate tanks are very heavy, and it is not desirable, unless a house is built expressly to receive them, to increase the weight by piling up rockwork inside them. In my case any serious addition to the combined weight of tank and water might cause the whole affair to subside from the study at the top of the house to the bed-room immediately below it, which would be an unpleasant circumstance, especially if it happened at night. But the bank of rocks at the back of the tank may be said to weigh nothing at all, consisting as it does wholly of old shells, and some of them very large, handsome, finely perforated and richly clothed shells of oysters from which the inmates departed many a year before. I found the shells weather-beaten on the beach. Please make a note of this therefore, and if you are fitting up an aquarium, secure for it a few hampers of sea-side findings of an ancient shelly kind, and let the chief bulk consist of the largest and most ancient of the beach-strewn oyster shells you can obtained. They are worth all the cost of[illegible] and more to an enthusiast in those matters, as will be seen presently.

The tank was fitted with these substitutes for rock, and

filled with sea-water. I put in about half-a-dozen tufts of Ulva and Enteromorpha, and after four days had elapsed I stocked it with animal life as follows:—Six *Actinia mesembryanthemum*, two *Sagartia viduata* (anguicoma), four *Sagartia bellis*, four *Bunodes gemmacea*, two *Sagartia dianthus*, one fine block of *Corynactis viridis*, and twelve periwinkles. I left all alone for a week, and at the end of that period most of the zoophytes had shrunk up, refusing any longer to display their gorgeous rays of flowery tentacles, and a black spot in one corner told of a death that had occurred. I soon found that the defunct party was a periwinkle, and he was removed. Three or four days afterwards a slimy appearance and a slight cloud indicated another death, and this time it was one of the *Bunodes gemmacea*. The next day I lost a *mesembryanthemum*.

When the last corpse was removed, a cloud rose from the spot where it had lain—the thermometer in the room being then at 83°, and the water was in a bad state. I was compelled, therefore, to remove the animals to a shallow pan, and leave them uncovered for a time, while I filtered enough water through charcoal to enable me to cover them with a thin film. The remainder of the water was exposed in a vessel to the sunshine for three days, and the empty tank was well cleansed and dried, and the shells exposed to sunshine to effect a perfect purification. While in the shallow pan I lost my block of *Corynactis*—every one perished. The tank was refitted, but the water was by no means so bright as when it was dipped from the salt sea. I made good what had been lost by evaporation by adding fresh water till the specific gravity bulb showed an inclination to sink. The same day a fine *dianthus* floated about instead of adhering; all the rest adhered well, and there was a fine display of tentacles, as is commonly the case after the animals have been disturbed. I removed the *dianthus*, and gave him a vessel to himself; but he never took hold, and died without a murmur. In the course of the summer I lost two more periwinkles; but though they lay some time decomposing before I knew it, I did not disturb the water, being content to remove them quietly, and leave the water and its inmates to fight it out.

From the time of first fitting the tank to last Midsummer-day was a period of three years. On that day, considering the experiment satisfactory and sufficiently lengthened out, I distributed the little collection. At the time of distribution the stock consisted of five *A. mesembryanthemum*, two *S. viduata*, one *S. dianthus*, four *S. bellis*, four *B. gemmacea*, and eight periwinkles. The state of the tank was also very different to what it was for some months after the first furnishing.

During the first winter all the tufts of Ulva and Enteromorpha perished. I thought then, and I still think, that in winter such a tank ought to be turned round to face the light, and be turned back to its former position some time at the end of February or the beginning of March. I wish I had done so, it would have made the experiment more complete probably. However, I did not; the fact is, such things are not easily moved, and so, if it occurs to one's mind to move them, the intention is scarcely likely to be carried into effect. Before the first winter set in, there was a perceptible green growth on some of the shells and stones, but not till the summer of 1863 was the growth of vegetation at all general. Then I became aware of the immense value of the old shells; for the old, rough, much pierced, and sponge-covered oyster shells acquired a rich deep green hue, and equally well clothed were the shells of the barnacles. On these latter, indeed, vegetation *first appeared*, and they are, no doubt, invaluable if well cleansed of animal matter before being inserted. But from first to last there has never occurred a single instance of "pea-soupiness," no ropy confervæ have been produced. The vegetation amounts to no more than a velvet-like, deep green coating on shells and stones, and this is richest on barnacles and oyster shells.

In every case of death subsequent to those particularized above, I have allowed the water to right itself, which it does in the course of a few days, or a week, the cloud spreading at first all over the tank, and then contracting to a black spot, which marks where the animal perished, and in the course of a fortnight (or less) this entirely disappears. It is an important fact that when the animals become seasoned, and the whole affair is left alone, one death does not necessarily lead to another, as in a tank heavily stocked, and exposed to a strong light; but as soon as the cloud caused by decomposition begins to spread, all the creatures close their disks, the mollusks contract and draw down their operculi, and in this state of torpor they all remain till things improve, when they again resume their activities. The most frequent cause of impurity is the result of feeding; for scraps of oyster or mussel given them are sometimes immediately ejected, and fall among the shells, and remain hidden, to cause putrefaction. The only means of preventing this is to remove every particle of food not received by the animals; to feed seldom, so as to increase the probability that food will be welcome; and, lastly, to feed only on bright mornings, when the water is nearly transparent. Once a fortnight is often enough to feed all the summer, and once in five or six weeks during winter.

During the first few months after the tank was fitted, it

had much attention, and was kept to a regular standard of density. By degrees I slackened in my attentions, and this did not result in disaster. Once, during the summer of 1863, after long absence from home, and much absolute neglect of the tank, I observed that the water had sunk to a low level, and I inserted a hydrometer. What was my horror to find it register a specific gravity of 1,416! Yet even then the *mesembryanthemums* appeared as lively as usual, and *dianthus* was slowly imbibing and contracting, puffing itself out to enormous dimensions, and then becoming constricted, as if tied with a cord, as is the wont of this lovely conjuror of the deep. I found after a time that instead of adding fresh water by slow degrees, as I did at first, I might add sufficient at once to reduce the specific gravity to 1,028 without any harm to the inmates. They would, perhaps, close for a few minutes, and then shine out with greater splendour than before. In every case when the water acquired an unnatural degree of density, the periwinkles attached themselves firmly, shrunk down deep into their shells, and drew their shutters down as tight as possible, and so remained till things came right again, when they would make up for lost time by increased activity and voracity. Since then the tank has frequently lost as much as two inches depth of water by evaporation, and I once found the specific gravity to be 1,529! Yet nothing worse happened than a general torpor and constriction, and a few hours after the reduction of the density to a proper standard, the creatures were all as lively as ever.

I have referred to cloudiness caused by deaths, but it is right I should say, that with the exception of those few occurrences, the tank has always been delightfully bright, and there never occurred any growth on the front glass. When unstocked on the 24th of June last, the water had the same bright appearance as when it was first dipped in the English Channel; but there were floating on the surface some small patches of brown flocculent matter, a sort of scum which I thought resulted from a gradual accumulation of a linty sort of dust, the result of the tank being amongst books, and which had crept in by the small slit of the sixteenth of an inch which intervenes between the edge of the glass cover and the side of the tank at each end. The water was always rich in microscopic life, and its capacity for sustaining a mixed collection of marine animals appears to be in the proportion of not more than one to a gallon. For so large a creature as a *dianthus* I should think two gallons none too much, with a shallow vessel, and vegetation produced *in situ* as essential elements of success; whereas with similar advantages two *mesembryanthemums* or daisies might be kept in a gallon of water. Even a periwinkle needs nearly a gallon

of water, spread out over a considerable surface, to keep it alive two or three years. But by adopting this liberal rule, we make an end of the necessity for ærating, and for frequently renewing the stock of plants and animals.

PLEASANT WAYS IN SCIENCE.

No. I.—Curiosities of Motion.

Under this title we propose from time to time to consider divers scientific questions in an informal manner, seizing rather upon their amusing, pictorial, or ideal aspects than attempting to build them up into the technical form of a methodical treatise. Our object is to bring interesting results within the reach of those who may not have time or opportunity for arriving at them through a regular course of study, and to render assistance to those who diligently collect facts, but require help in the art of associating them together, so as to form a philosophy. We shall begin with some entertaining facts concerning Motion.

Of all earth's millions of human inhabitants how few know when they awake in the morning what enormous journeys they must take before the day will be over, and the dawn of the morrow will greet their eyes. It would alarm a Londoner to tell him at daybreak that he should be shot off to Persia with the speed of a rifle bullet; and indeed we know no artificial mode of spinning him onward at anything like such a rate, even for short distances, with due regard to the continuance of his life. Nature, however, rolls him along with tremendous speed as the earth careers from west to east. In the course of twenty-three hours fifty-six minutes, four seconds, and nine hundredths of a second, the earth turns round on its imaginary axis. If at any moment we thought ourselves upright, we must remember that since that moment flitted away, we have been turned topsy-turvy, and brought right again exactly in that space of time. How do we know this? It is one of the many things which the stars tell those who worship them with the homage which science pays to their brilliant and yet *unseen* orbs.* If we set up a tall convenient mark, or take a distant church spire, a lightning rod or a flag-staff, and note when any particular star is exactly over it, in precisely the time we have given, that star will be again in its place; and as

* The reader may consider as part of this series the paper, "We never See the Stars," which see to explain the paradox in the text. (See Vol. v., p. 47.)

all stars tell us the same tale, we accept their evidence that our big earth-ball, which at the equator is nearly twenty-five* thousand miles in circumference, turns round its own axis in a little less than twice twelve hours.† Now if we could get a fairy stool to stand upon nothing, above the earth's surface at the equator, and we could sit upon it, and watch the globe spin round, it would in the course of a day and night spread before us its five-and-twenty thousand miles of successive scenery. Great cities with their "cloud capped towers" and "gorgeous palaces," cultivated fields, primeval forests, desert lands, and ocean with its varied shores, would come and vanish like the thoughts and pictures of a wondrous dream. According to this supposition we should be quite *still*, while every point on the equatorial circle would travel through a space equal to the globe's circumference in its daily journey. As facts go, we are practically still, or move so little in the course of the day that we may be considered so, and the globe takes us round with it in the prodigious tour we have described, not bringing before our eyes a succession of terrestrial scenes, but unfolding the heavens as a scroll, and enabling us to read their glorious characters as successive portions rise to our view in the east and vanish in the west. The earth's velocity of rotation at the equator is 1520 feet in a second—rather less than the initial velocity of a rifle-ball. In our latitude it is about 820 feet per second.

In addition to this journey of rotation, we have another one to take, namely, that of revolution round the sun, and this we accomplish at an average rate of sixty-eight thousand and forty miles an hour.

Thus, two swift motions operate upon us, and we feel them not—only know them by reasoning from facts that afford no evidence of them to an uneducated mind. The common eye cannot fail to see the sun, and moon, and stars rise and set. A more watchful eye notices that at different seasons our skies exhibit different groups of stars, in regular and recurring succession.

* The diameter of the earth is 7925·604 miles, and its circumference 24,809 miles. The circumference of a circle is rather more than three times its diameter, say 3·14159 times.

† It is not necessary for our present purpose to take into account the effect produced upon the period between two successive advents of any star on the meridian, by the motion of the poles of the earth, which do not constantly point to the same place in the heavens. For explanation of this, the reader can see Sir J. Herschel's *Outlines of Astronomy*. The difference between a solar day, averaging twenty-four hours, and a sidereal day, must be borne in mind. As the change in the position of the earth's poles is small and slow, and as the stars are too remote for their proper motions to affect the question, we may consider them as fixed points, to which the same meridian returns in equal times. The sun does not appear fixed. It seems to traverse the heavens in its annual motion in a direction opposite to its diurnal motion, so that the latter motion appears slower than the diurnal motion of the stars, and the solar day is so much longer.

Thus, something must move—but what, and how? The pole star moves so little, or in so small a circle, as to seem the pivot about which the heavens turn, and if all the stars were supposed fixed in crystal spheres, the motions of such spheres would account for very much that is observed. Thus, the ancients for a long time had no notion of the true system. They took the earth for a thing firmly fixed, or rooted, and ascribed all celestial movements to other bodies more or less distant from it. A greater precision of observing power, and a larger store of facts, gradually revealed the real state of the case.

How do we ever know that we move or are moved, or that anything moves? In the earth journeys we unconsciously accomplish we have illustrations of motions that carry us along and which we cannot feel. On a dark night, or with eyes shut, in a railway train, a rumbling and shaking informs us that we are not still; but we easily get confused as to which way we are going, if the motion is smooth enough not to force the fact upon our attention. Our chief evidence that motion has taken place is derived from the information afforded by our eyes that certain things have changed their relative positions. If an object seen one minute on our right, is seen the next minute on our left, either the object has gone half round us, or we have gone half round ourselves. If two objects are situated in front of us, so that when we look straight a-head we can just see both together at the same time, and if a few minutes later we can only see one at a time, either they must have receded from each other, or we must have approached them, so that their actual distance occupies a greater apparent space than it did before. At a distance, the view of a whole town is compressed into the size of a sixpence a foot off of our eyes; nearer, a single brick is more than we can see at once. Let us suppose that we see the town in its sixpenny dimensions, and that presently its apparent magnitude far exceeds the capabilities of a single glance. How can we tell whether we have walked to the town, or the town has walked to us? "What a ridiculous question," would be a general exclamation, and yet how many supposed well educated people could give an intelligible proof of what really occurred? It would not do for them merely to say that they knew they moved on, because they passed things on the road. We should ask how they knew the things did not pass them. If two bodies are moving in opposite direction, with equal or different velocities, their positions with reference to each other at any given moment will be the same, as if one kept quite still and its motion were added to that of the other, and in order to prove whether one or both had moved, reference must be made to some fixed and ascertainable point.

Being parodoxically inclined, we will add that such a *fixed* point may be a rapidly moving one, and will do just as well, nay, in most cases, it would not enjoy the merit of what we call "fixity" if it did not travel at a great rate. Suppose Westminster Abbey were miraculously impressed with, and enabled to perform, the duty of standing still, while Charing Cross and the Houses of Parliament went with the earth's surface on its diurnal tour; the angle made by lines connecting these buildings, as seen from Charing Cross, would rapidly change, and the inhabitants of London, not let into the secret, might think the old abbey was running away. As the earth moves, carrying along with it its burden of hills, buildings, and trees, the "fixity" of any one of these objects depends upon its partaking of exactly its own share of the motion common to all. The motion of the earth, from west to east, does not hinder the railway from carrying us from east to west. It is as easy to walk from St. Paul's to Charing Cross, as from Charing Cross to St. Paul's, and no passenger feels whether he is going as the earth goes, or in opposition to her diurnal course.

In order to become aware of motion we want comparison. An object moving on the earth's surface in a direction or with a velocity different from the direction and velocity common to all territorial objects, manifests its special motion by taking up a new place in reference to other objects, and we assume that the other objects have not moved because their position is unchanged with reference to each other.

In the smoothest form of travelling, if we do not look at objects for comparison, we scarcely know that we are moved. If a jerk occurs, one part of our body immediately complains that its position, with reference to other parts, is violently changed. An extreme instance of this sort of action is when a cannon ball takes off a leg by communicating to it a velocity with which the rest of the unfortunate individual cannot possibly keep pace.

The velocity with which certain motions take place is far beyond our possibility of conception. We see them expressed in lines of figures that soon cease to have any meaning which understandings can grasp. An uneducated man has no conception of a few thousands. To a savage, all beyond twenty or a hundred is vaguely presented as a great many. An ordinary man of business grasps the notion of a million, though only to some extent. Billions, trillions, and their connexions, seem all alike—vast, vague, and not to be comprehended. An astronomer or mathematician penetrates their mysteries up to a certain point; but he is soon brought to a condition of non-apprehension, and gigantic numbers come at last to mean to

him just what smaller numbers do to the savage—a quantity greater than he can adequately comprehend.

Astronomy brings us into acquaintance with motions of enormous velocity traversing prodigious spaces, chemistry and physics exhibit motions equally wonderful for their incalculable speed, and yet performed in spaces too minute for us to conceive. A swallow in its swiftest flight is said to move at the rate of ninety miles an hour; Mercury, in its journey round the sun, performs about 109,360 miles in an hour;* Venus, being less near the centre of our system, is contented with a march of 80,000 miles an hour; while our earth, in the same time, traverses 68,040 miles. These are wonderfully quick motions, but they are nothing to the velocity of light, which travels, according to recent experiments, at the rate of about 185,000 miles in a second.†

A great quantity of evidence leads to the conclusion that light is a motion of an extremely subtle fluid, as sound is the motion of air.‡ Now, wave motion is somewhat complicated. If two persons hold a long rope, and one lifts his end rapidly up and down, a wave motion visibly passes from one end to the other. A portion of the rope rises and falls, passing its motion on to the next portion, until the whole rope is affected by a beautiful series of wave lines. Now the velocity with which each portion rises and falls is one thing, and the velocity with which the wave form is transmitted from one part to another is another thing; and when wave actions take place, there may be an enormous difference between these two velocities. When we speak of light coming to us from sun or star with a rapidity of 185,000 miles a second, we mean that the *wave form* reaches us with that degree of speed; but the velocity with which the ether particles rise and fall in their vibrations is infinitely more swift. When we investigate sounds, we find their pitch depends upon the slowness or rapidity of their motions—a metallic strip that vibrates with great rapidity giving an acute sound, which becomes graver as the velocity of vibration is diminished. A complete vibration is the oscillation of a particle once forwards and once backwards through a greater or smaller arc. The intensity of a sound depends on the size or amplitude of the vibration, and its pitch upon their velocity.

* These figures are taken from Sir J. Herschel's *Outlines of Astronomy*.

† This velocity of light corresponds with the distance now assigned to the sun upon astronomical grounds—namely, 91,600,000 miles.

‡ It must not be understood that sound is exclusively produced by vibrations of common air. In *Ganot's Physics*, translated by Atkinson, we find it well stated that "sound is a peculiar sensation excited in the organ of hearing by the vibratory motion of bodies, when this motion is transmitted to the ear through an elastic medium." Solids and fluids will conduct sounds, and so will all gases. The sounds we commonly hear and make use of are vibrations of atmospheric air.

By comparing the note yielded by vibrations whose velocity was known with that of the buzzing of a gnat, it has been estimated that this little creature vibrates its wings fifteen thousand times in a second.*

We have spoken of the velocity with which the forms of light waves travel, so that they reach us from the sun in eight minutes, thirteen seconds, and three-tenths of a second. Tremendous as is this speed, it looks small when compared with that of the vibrations which the ether particles experience. Thus, "when the ether makes 450 billions of oscillations in a second, the sensation of red light is produced, while 780 billions of oscillations in a second produce violet light."†

If light only takes a trifle more than eight minutes to come nearly ninety-two millions of miles from the sun, the time occupied by its passage across an ordinary room would seem too small for possible appreciation, and yet M. Foucault experimentally determined its velocity by operating in such a limited space. His proceedings illustrate the important results that may flow from the employment of accurate means of measuring very small quantities of motion. Before attempting to explain the use made by M. Foucault of Mr. Wheatstone's revolving mirror, let us call attention to a well-known electrical experiment, in which a number of spokes set in a circle are made to revolve rapidly in a dark room. They are then illuminated by an electric spark, and found to *appear* at rest. The light has come and gone so fast that the spokes have not had time to make any appreciable change of position. We need not be surprised at this when Wheatstone found that the spark light‡ "does not last the millionth part of a second of time," yet this minute time sufficed to make the light vibrations to excite the optical apparatus of the human eye, by communicating to it a quantity of motion sufficient to cause the sensation of light.

As a step towards understanding Mr. Wheatstone's measuring apparatus, let the reader take a small looking-glass in both hands, holding it up by the middle of the frame, and gently spin it round so that the bottom shall be where the top was, and *vice versâ*. Let a candle be placed in front of this mirror, so that at the moment it stands upright it shall throw a reflection of it upon the wall. The reflected image will then occupy a certain spot on the wall, and as often as the mirror comes round to the same place, it will throw the reflection on the same spot. If, however, immediately after one reflection has been thrown on the wall, the candle is moved before the

* *Ganot's Physics*, by Atkinson, p. 164.
† *Ganot's Physics*, by Atkinson, p. 404. ‡ *Noad's Electricity*, p. 116.

mirror comes back to its place, the second reflection will be on a different spot to the first, and the distance between the two reflections will enable an experimenter to tell how much the candle has been moved. If, moreover, the time occupied by the mirror in rotating is known, it will become evident that in that time the candle's motion was effected.

Let us now suppose a mirror rotating with great velocity, that a ray of light falls upon it, and is reflected by it on a given spot. Let this same ray of light, after traversing a certain number of feet, be a second time thrown upon the mirror, and a second time reflected by it. If during the time occupied by the ray of light in the journey it made between the first reflection and the second was sufficient to allow the mirror to perform any appreciable part of its rotation, the light ray must, on its second arrival at the mirror's surface, have struck that surface at an angle differing from the first. It is evident that as light moves so quickly, the mirror must be very quick for the faintest difference of position to have occurred; but by making a rotation of 600 to 800 turns in a second, and by viewing the image through a magnifying eye-piece, M. Foucault obtained a sensible distance between the first and second reflections, although the light only passed through a space of twenty-seven feet.*

In the present state of science, we seem justified in regarding light, heat, and elasticity as modes of motion, and we may suppose that they all exhibit the two kinds of motion we have described—the oscillations of particles in a limited space, and the indefinite propagation of the wave form. Heat is also a mode of motion, and a continual cause of motion in every substance and particle that it acts upon. Heat performs two functions, which are evidenced in a different manner to our senses; it expands bodies by forcing their particles further apart, and it makes bodies hot by communicating to their particles a particular kind of motion. If a certain quantity of heat is added to various substances, it will not make them all equally hot; but the heat which does not make itself cognizant to our senses in the form of augmented warmth is occupied in internal work, and produces a movement of particles that may become known to us in some other way. "To raise a pound of water one degree would require thirty times the amount of heat necessary to raise a pound of mercury one degree."†

When chemical attractions operate powerfully, as when a mixture of oxygen and hydrogen is ignited by an electric spark, the atoms of the gases rush together with inconceivable

* *Ganot's Physics*, already referred to, contains a description, with diagrams, of this experiment.

† *Tyndall's Heat as a Mode of Motion.* Second Edition, p. 146.

velocity, and out of this intense development of motion a sudden heat ensues.

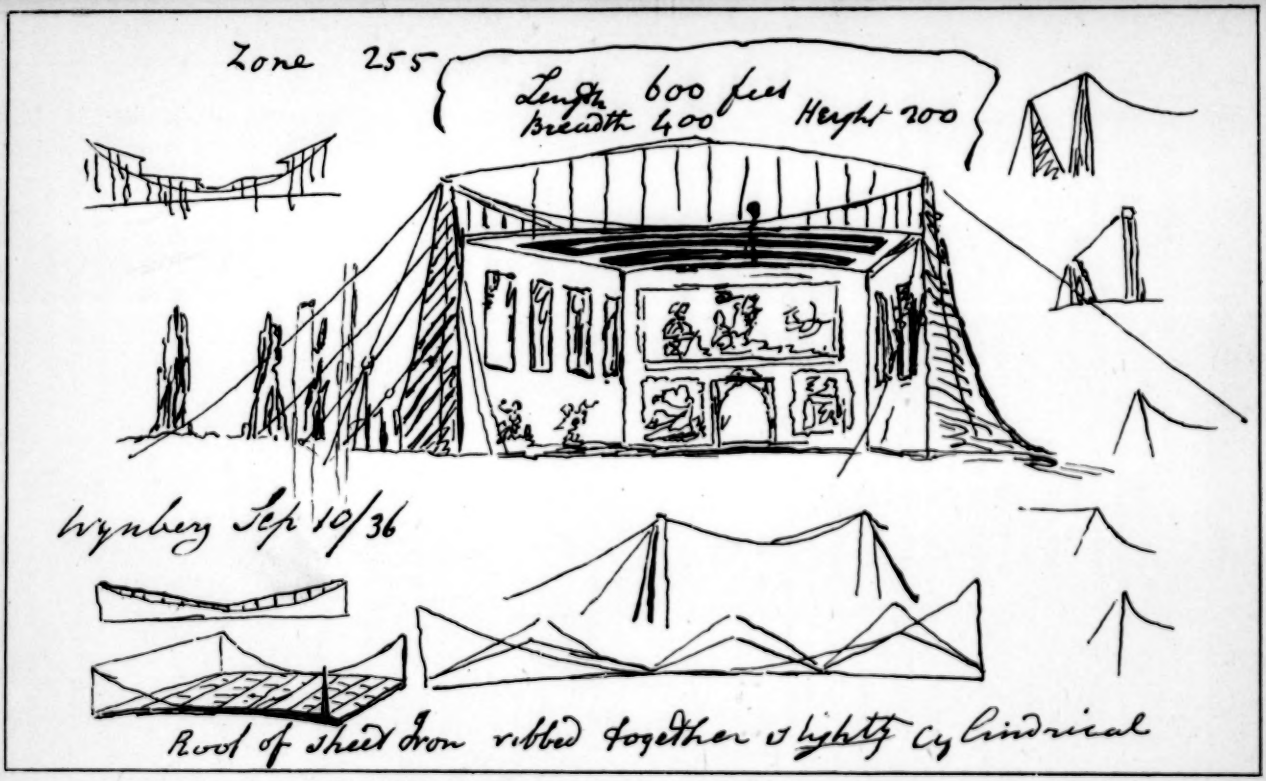
Heat, magnetism, and electricity are ceaselessly occupied in generating motion, so that no substance we are acquainted with is absolutely still. As a mass it may be at rest; that is, it may only partake of its necessary share of the common motion of the globe and the system to which it belongs; but its molecules are never quiet. The least change of temperature moves them more or less, the least change of position places them in a different relation to the magnetic axes of the earth, and then again a change is produced, at any rate, in most bodies. Every house affords an illustration of the way in which internal motions occur in substances that might be thought free from detrimental disturbance. Bell-wires become rotten because the particles of the copper have rearranged themselves in a new form, by which cohesion is lessened; and iron has a tendency to grow brittle, apparently under the influence of continued concussions, though this is not perfectly clear. A piece of glass tube might be thought a settled thing, so far as its internal structure is concerned, but thermometer makers tell us that if newly-made tubes are exactly graduated, sufficient changes are likely to occur in the course of a few months to affect the accuracy of the instrument. Metallic substances, such as gold and German silver, are employed to make the vacuum chambers used in the construction of aneroid barometers, and these, too, are subject to molecular motions, which change the elastic power of their delicate walls, and no one has yet arrived at the art of making these vacuum chambers so as to insure this action being so small as to have no practical effect in lessening their accuracy. Those which stand tests for six or more months are likely to remain good; but a new instrument, good to-day, may be worth little next year.

From the internal motions to which all bodies are subject, it is very difficult to make a good standard measure of length, and such a standard can only be perfectly right at the exact temperature to which it was adjusted. Instruments have been contrived by which motions of expansion and contraction can be measured to infinitesimal portions of an inch, and by which the exact length of any object can be taken, or the minutest deviations from a true plane surface detected. As a specimen of this class of instrument we may mention a *planometer*, and our description is taken from one constructed by Mr. Browning. An aluminium circle stands upon three legs, arranged at equidistant points of its circumference, and of precisely the same length. In the centre of the circle is another leg, which can be elevated or depressed by a delicate screw, and the extent

of this movement read off on the edge of the circle by a vernier. If all four legs are exactly of the same length, and the instrument is placed on a plate of glass, or any other substance which is not a true plane, one or more of the legs will not touch the surface when the others do, and if a slight angular shove is then given to the instrument it will revolve about the central leg if that leg touches any point, which it can easily be made to do. We took a plate of glass which all four legs touched, and then we expanded a portion of the glass by the heat of one or two fingers imposed upon it for a minute. The particles of the glass experienced sufficient motion to lift some legs of the instrument higher than the others, and this extremely slight movement allowed us to rotate the instrument about its central leg. This particular instrument will measure inequalities not exceeding a fifty-thousandth of an inch.

Another kind of instrument, by which the amount of motion performed in infinitesimal quantities of time can be estimated, is called a chronograph. In this sort of apparatus there must be a uniform rate of motion impressed upon one part, say a wheel, and this part must transmit its motion through long levers and through larger wheels, so that a very small motion of the first part leads to a very much greater motion of some other part. If one part moves through an infinitesimal space for a hundredth, a thousandth, or a hundred thousandth of a second, it must cause another part to move enough for the eye, with or without optical aid, to be able to see and measure the space that has been traversed. As an illustration of one way of using such a machine, let us suppose that an electric current suddenly sent through it sets it going, and at the same moment fires off a gun. Let the ball strike and cut through the wire conveying the current, and instantaneously stop the machine. An observer can then see that the index hand of the apparatus has moved through a space corresponding with a given portion of time, say a thousandth of a second, and thus he knows that from the firing of the gun to the ball's striking the wire a thousandth of a second elapsed.

Motion is a necessary condition of life. In a living organism everything moves. If new matter is taken in and digested we have nothing more than a regulated series of motions, by means of which food substances are taken to pieces in a methodical manner, and their atoms built up in fresh forms. If old matter is eliminated from the system, here again are motions regulated as to their character, their quantity, and their velocity. If we see, motion is communicated to the eye; if we hear, motion is communicated to the ear; if we think or feel, motion affects the brain. Countless myriads of regulated and co-ordinated motions occur every instant that an animal lives. Change their order,



Facsimile of a Sketch by Sir J.F.W. Herschel Bt. in 1836, in illustration of the possible construction of a Suspension Roof, for a Hall of large dimensions. ———

their character, their direction, their force, their co-ordination, and it dies, and then physical and chemical actions, with the co-operation of the minute organisms which the microscope reveals, pull the fabric to pieces, imparting new motions to its molecules, and as soon as they are dispersed, other forces imparting motion take them in their grasp, arranging them in fresh patterns, causing them to enter in new combinations, again to be destroyed by other motions, reconstructed again, and thus "On, on, for ever."

CHAIN SUSPENSION ROOFS.

BY SIR JOHN HERSCHEL, BART., K.H., ETC., ETC.

(*With facsimile of the Original Sketch.*)

We have much pleasure in publishing the following interesting letter from Sir John Herschel, and in presenting to our readers a lithographed *facsimile* of the original rough sketch embodying his design.

The principle of this mode of construction will be readily intelligible to engineers; but for the benefit of those who are not accustomed to rough diagrams, we may state that the sketch represents (the front wall being removed) a perspective view of the interior of a great hall. A light iron roof, of double convex form, and internally strengthened by angular supports, is kept in its place by chains, attached to it, and passing over the side walls of the apartment, which act like the piers of a suspension bridge. This we take to be the plan of M. Lehaire, and if so, it will be seen that Sir John Herschel had anticipated him by thirty years.

To the Editor of the Intellectual Observer.

Collingwood, *October* 3, 1865.

Sir,—In your number for September I observe the following notice under your miscellaneous heading, "Roofs on the Principle of Suspension Bridges." "M. Lehaire, a French civil engineer, proposes to construct roofs having a span very far greater than hitherto attempted by supporting them with suspension cables. They will have an advantage over suspension bridges in being free from the injurious effect produced by varying loads."

Allow me, in the absence of any further knowledge of M. Lehaire's suggestion, to submit for your inspection (and if you think proper, for that of your readers, through the medium of a woodcut) the exact *facsimile* of a rude sketch of a plan for constructing a hall 600 feet in length, 400 in breadth, and 200 in height, which I find preserved among my papers, and which, if the date it bears be (as I have no doubt it is) that of its execution, assigns nearly thirty years for the lapse of time. The handwriting is the same with that of the other memoranda on the paper, and the discolora-

tion of the ink, which is pretty considerable, also exactly similar. On first turning up the sketch, I had some doubt on this point, my habit of dating during the latter part of my residence at the Cape being "Feldhausen," the name of my residence, an insulated house near Wynberg; but from the subjoined extract of a letter from Captain Horsburgh,* I find that I was occasionally also in the habit of dating from Wynberg.

I have the honour, etc., etc., sir, your obedient servant,

J. F. W. HERSCHEL.

P.S.—The roof proposed being light, no great strength of cable would be necessary. A series of wire ropes, like those which supported the old suspension bridge over the Rhone at Valence, would answer every purpose, and be very cheap.

ON THE SIZE OF TELESCOPIC STAR-DISKS.

BY THE REV. W. R. DAWES.

WE have much pleasure in laying before our readers the following important letter from Mr. Dawes, on a subject now exciting very general attention:—

"The remarks in the INTELLECTUAL OBSERVER of July and October, on the little discussion which has arisen respecting the size of telescopic star-disks, seemed to show that the object of my statements on the subject was in some respects misapprehended.

"My remarks at the June meeting of the Royal Astronomical Society had specific reference to two points on which it was desired to ascertain the results of careful experiments—namely:—

"'1. Is the size of telescopic disks influenced by the *different curves* used by opticians for the correction of the spherical aberration of an object-glass?

"'2. Is it affected by the ratio of the focal length to the aperture?'

"It was distinctly understood that *the spherical aberration was well corrected*, though by different curves, in all the object-glasses compared; and that the observations were made on the *same star*. My reply to the questions expressed simply, that the results of numerous comparisons which I had made with telescopes by the eight different opticians named, had proved that the variety of the curves employed by them produced no perceptible difference in the size of the disk, and

* (EXTRACT.)

"MY DEAR SIR,—Your valuable and esteemed letter, dated Wynberg, July 7, 1834, etc., etc.

(Signed) "JAS. HORSBURGH.

"Sir J. F. W. Herschel, Wynberg,
"Cape Town, Cape of Good Hope."

also that I had come to the same conclusion with reference to the ratio of the focal length to the aperture. Except the difference of the curves, and of the ratio of the focal length to the aperture, all other things were supposed to be alike. The magnifying power, for instance, being as nearly as possible the same. The outstanding chromatic dispersion produces no effect on the *size* of the disk, but only on its *colour*, which is of course very perceptible under high magnifiers.

"The application of a circular patch to the centre of an object-glass has been frequently employed in my double-star observations since the year 1831; having been suggested to me by Sir John Herschel, in a letter dated in that year. It is also mentioned in the introduction to his *Measurements of 364 Double Stars*, published in 1832, where he says, 'The action of a telescope is often surprisingly improved by stopping out the central rays by a round disk from a fifth to a sixth of the diameter of the object-glass, which should be well centred.' See *Memoirs of Royal Astronomical Society*, Vol. v., Part i., p. 48. And in the introduction to my first series of double star measures, I have recorded my use of it, and have remarked, 'The effect is decidedly good on the stars themselves, if not too faint to bear the loss of light. The *separating* power of the telescope is increased, but the concentric rings accompanying bright stars are multiplied, and rendered more luminous, and are also thrown further from the disk. Hence small stars may often be obscured or distorted by the ring passing through them.' (*Memoirs of Royal Astronomical Society*, Vol. viii. p. 63.)

"The effect of the different degrees of transparency in object-glasses, arising from the different colour of the glass, is very small comparatively, as may easily be proved by comparing together the separating power of a refractor with that of a good Newtonian (metal) reflector of the *same aperture*; the refractor having a central disk on the object-glass of the same size as the plane mirror of the Newtonian. The reflector will not have more than half the *illuminating* power of the refractor, yet the difference in its *separating* power, arising from the smaller size of the disks, will be but trifling, much the same in fact as if the close stars of ζ *Cancri* were both of the size of the smaller of the two.

"To assert, as Dr. Steinheil supposed I did, that with a given aperture, the disks of *all* stars, whether of the 1st or the 9th magnitude, would appear of the same size, would be simply absurd. It appears that he overlooked the limitation distinctly expressed by the President in the words, 'With regard to the size of the spurious disk of the *same star*,' etc., and it was to this that my reply referred.—I am, sir, your obedient servant,

"W. R. Dawes."

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1865. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 33°*	Temperature of Air.	Calculated. Dew Point.	Tension of Vapour.	Relative Humidity.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively. Proportion of Sky clouded. 0—10	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°			inches.
July 1	29·750	55·8	46·5	·454	·72	68·3	52·5	15·8	10, 8, 3	NW by N, N by E, NW by N.	0·350
„ 2	...	...	...	...	...	73·9	48·1	25·8	...	... ...	·004
„ 3	30·060	67·9	53·7	·678	·62	76·7	49·6	27·1	4, 6, 1	WSW, SW by S, —	·000
„ 4	29·959	71·7	54·9	·768	·57	80·0	50·7	29·3	1, 2, 3	S by W, S by W, SW.	·000
„ 5	30·052	67·7	60·2	·674	·78	76·8	61·0	15·8	6, 6, 3	W by S, SW, SSW.	·000
„ 6	29·835	70·3	66·5	·734	·88	80·3	61·1	19·2	7, 9, 3	E, W by S, E by N.	·123
„ 7	29·754	63·4	54·3	·585	·74	70·6	60·6	10·0	8, 4, 2	SW by S, SW by W, S by W.	·500
„ 8	29·783	63·3	53·7	·583	·73	70·9	58·5	12·4	8, 7, 7	SW by W, SW, SSW.	·012
„ 9	...	...	...	...	...	70·1	55·2	14·9	...	... ...	·000
„ 10	29·837	56·9	51·9	·471	·84	65·7	53·9	11·8	8, 6, 9	W by N, W by S, —	·135
„ 11	29·695	58·9	47·9	·504	·69	67·4	53·4	14·0	9, 8, 4	WSW, SW by W, NW.	·023
„ 12	30·021	58·6	49·0	·499	·72	67·9	46·9	21·0	6, 8, 7	W, NW by N, W by N.	·000
„ 13	29·920	56·3	55·0	·462	·96	65·4	53·0	12·4	10, 10, 10	SW, SW by S, SSW.	·061
„ 14	29·892	64·7	57·0	·611	·77	74·3	54·4	19·9	9, 4, 3	WSW, SW, SW by W.	·051
„ 15	29·853	71·0	62·1	·750	·75	80·4	50·1	30·3	1, 0, 0	SSE, S, SW by S.	·000
„ 16	...	...	...	...	...	77·4	62·1	15·3	...	... ...	·000
„ 17	29·915	62·5	62·1	·568	·98	71·9	60·7	11·2	7, 10, 10	NW by W, NW, NW.	·040
„ 18	29·865	57·8	51·3	·486	·80	68·8	53·7	15·1	4, 10, 10	SW by S, SSW, S.	·171
„ 19	29·787	60·8	53·3	·537	·77	68·7	52·1	16·6	9, 6, 8	SW by W, SW, SW by W.	·073
„ 20	29·817	64·3	52·1	·603	·67	71·9	48·2	23·7	4, 7, 6	S by W, SW by S, S by E.	·004
„ 21	29·825	62·8	54·9	·574	·77	71·8	50·1	21·7	9, 9, 10	ENE, E by S, NE by E.	·000
„ 22	29·722	63·2	53·1	·581	·71	72·3	59·6	12·7	9, 7, 7	ENE, E by N, SE by E.	·000
„ 23	...	...	...	...	...	68·7	59·0	9·7	...	... ...	·176
„ 24	30·161	66·3	59·0	·644	·79	75·3	54·5	20·8	10, 10, 8	—, —, —.	·083
„ 25	30·239	67·6	58·3	·672	·74	76·3	59·2	17·1	10, 0, 1	NE, E by S, SE.	·005
„ 26	30·311	69·5	54·5	·715	·61	78·8	54·3	24·5	1, 0, 0	N, SE by E, SE.	·000
„ 27	30·177	70·7	59·9	·743	·70	80·4	53·8	26·6	0, 9, 10	—, NW, NW by W.	·000
„ 28	30·224	62·6	47·4	·570	·60	72·0	51·1	20·9	5, 1, 2	W by N, WNW, W.	·000
„ 29	30·021	64·3	51·2	·603	·64	75·7	51·5	24·2	2, 4, 3	W by S, W, WSW.	·000
„ 30	...	...	...	...	...	71·8	56·3	15·5	...	... ...	·006
„ 31	29·737	56·3	50·4	·462	·82	66·6	48·2	18·4	9, 10, 10	SW, W by S, —.	·000
Daily Means.	29·931	63·6	54·6	·597	·74	...	...	18·5	...	... ...	1·817

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JULY, 1865.

	Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
	Hour.																																
	12	20	4	4	2	7	2	3	18	9	6	10	9	3	13	1	10	5	8	6	4	3	6	2	2	1	4	2	4	*	*	*	6·0
A.M.	1	16	4	3	2	8	3	4	15	7	5	9	6	6	10	1	10	6	7	6	3	2	5	2	2	2	4	3	4				5·5
A.M.	2	17	5	3	4	10	2	8	15	9	5	9	5	6	10	2	10	2	10	4	2	1	5	4	1	3	4	1	4				5·8
A.M.	3	17	5	4	2	9	4	11	15	11	5	8	5	7	8	3	10	3	9	4	5	2	6	3	2	2	2	1	7				6·1
A.M.	4	20	5	4	3	8	5	11	13	10	7	7	5	7	3	1	6	4	7	2	1	2	3	3	2	2	4	2	6				5·5
A.M.	5	19	5	2	2	10	6	13	15	9	5	9	7	8	5	2	8	4	10	3	1	2	2	5	1	4	4	3	6				6·1
A.M.	6	19	5	4	3	13	10	16	17	8	10	9	11	5	9	3	11	3	10	3	3	4	3	6	2	2	3	3	9				7·3
A.M.	7	18	6	5	7	12	7	16	20	12	10	12	13	17	13	7	13	4	12	5	6	5	3	7	1	2	1	3	12				8·9
A.M.	8	18	6	4	11	14	10	18	23	10	13	11	12	18	17	10	14	3	15	9	11	7	7	2	2	2	2	4	14				10·2
A.M.	9	20	6	6	14	13	18	22	22	9	11	10	12	18	16	11	13	4	14	11	14	8	6	3	2	5	2	6	12				11·0
A.M.	10	22	8	5	16	12	15	27	24	12	15	10	12	20	18	14	12	7	15	12	14	12	5	2	3	9	5	8	11				12·3
A.M.	11	20	7	6	17	13	10	28	28	7	17	9	10	21	17	16	14	6	16	13	16	12	3	3	4	8	8	10	11				12·5
	12	18	9	7	20	18	9	30	30	9	14	11	11	26	17	16	14	5	17	15	17	12	4	7	5	10	8	10	*				13·7
P.M.	1	17	8	9	23	15	6	30	30	12	15	12	11	25	20	18	15	4	18	14	19	14	5	5	2	11	8	9					13·9
P.M.	2	18	9	6	20	16	5	30	29	9	10	12	10	25	20	21	12	4	15	14	19	13	10	4	2	14	7	8					13·4
P.M.	3	15	7	9	19	17	7	25	29	17	12	15	10	20	20	21	11	7	14	17	15	11	10	4	6	11	7	8					13·5
P.M.	4	13	10	10	20	17	8	28	25	16	10	15	9	23	20	20	14	9	16	15	15	8	15	5	2	12	8	10					13·8
P.M.	5	12	10	8	16	13	7	25	20	12	3	14	9	22	18	22	12	8	15	15	15	8	10	4	2	11	7	7					12·0
P.M.	6	8	11	5	13	12	6	22	18	9	6	15	6	23	16	19	11	5	10	16	12	7	10	2	3	6	7	7					10·5
P.M.	7	7	10	5	8	9	12	16	14	7	6	10	6	19	13	14	7	5	12	10	8	5	7	4	4	5	3	13					8·8
P.M.	8	2	6	2	7	8	9	17	13	8	9	7	4	16	9	8	5	6	14	5	4	3	5	2	7	6	4	12					7·3
P.M.	9	3	6	2	7	8	9	17	12	5	9	3	4	13	6	5	4	6	12	4	4	2	5	2	4	5	2	12					6·4
P.M.	10	3	6	2	9	7	3	18	13	7	7	5	5	15	4	6	4	6	13	3	3	4	3	1	3	6	3	12					6·3
P.M.	11	6	4	1	6	6	2	14	10	7	8	7	4	12	2	10	4	7	5	4	1	3	1	2	3	4	3	5					5·2
	12																																
	Total Daily Movement.	348	162	116	251	275	175	449	468	231	218	239	196	377	304	251	244	123	294	210	212	150	139	84	67	143	110	159	100				9·2

* Anemometer clock undergoing repair.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865. Day of Month.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 3.30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·752	53·9	44·7	·73	·426	63·1	49·3	13·8	10, 7, 8	NW, SW, W.	0·860
„ 2	29·650	52·3	46·5	·82	·404	62·3	45·3	17·0	7, 9, 10	SW by W, SW, SW by W.	·010
„ 3	29·733	48·5	43·3	·84	·354	61·4	43·5	17·9	10, 8, 10	SW, W by S, SW.	·592
„ 4	29·976	55·0	43·4	·67	·442	64·5	45·7	18·8	10, 7, 1	NNW, N by W, N by W.	·208
„ 5	30·074	61·2	45·4	·58	·544	69·9	42·6	27·3	0, 4, 3	—, W, WSW.	·005
„ 6	...	...	...	...	...	69·7	51·4	18·3	...	...	·003
„ 7	29·816	63·5	58·2	·84	·587	72·8	58·2	14·6	9, 4, 10	W by S, WSW, W.	·015
„ 8	29·973	60·3	52·2	·76	·528	67·6	51·4	16·2	4, 9, 8	NW, NW by N, NNW.	·025
„ 9	29·871	63·9	51·4	·65	·595	73·6	47·7	25·9	1, 6, 8	—, SW by S, S by W.	·000
„ 10	29·703	61·7	55·1	·80	·553	73·1	51·4	21·7	9, 8, 10	SW by S, S, S.	·000
„ 11	29·551	60·9	59·7	·96	·539	67·8	57·5	10·3	9, 10, 9	S, S by E, S by W.	1·014
„ 12	29·739	59·4	54·6	·85	·512	67·6	51·2	16·4	8, 10, 10	S, S by W, —.	·040
„ 13	...	...	...	...	...	68·7	53·8	14·9	...	...	·026
„ 14	29·737	59·5	54·9	·86	·514	69·4	53·9	15·5	9, 8, 9	SSE, S by W, S by W.	·062
„ 15	29·538	60·6	60·1	·98	·533	66·5	54·6	11·9	10, 10, 9	SW by W, SW, SSW.	·159
„ 16	29·694	59·5	50·7	·74	·514	65·9	53·9	12·0	7, 5, —	SW, WSW, W by S.	·017
„ 17	29·795	58·0	50·0	·76	·489	64·8	53·1	11·7	6, 8, 9	W by N, WNW, W by S.	·106
„ 18	29·849	59·1	49·9	·73	·507	68·1	54·4	13·7	6, 8, 9	NWby N, N by W, NW by N	
„ 19	29·922	61·9	51·0	·69	·557	70·0	45·8	24·2	0, 3, 4	—, E by N, E by S.	·007
„ 20	...	...	...	...	...	71·8	52·3	19·5	...	...	·000
„ 21	29·738	63·2	54·1	·74	·581	72·0	54·2	17·8	5, 3, 7	W by N, W by S, W by S.	·238
„ 22	29·688	64·5	51·8	·65	·607	72·0	55·6	16·4	0, 5, 7	WNW, NW by N, —.	·000
„ 23	29·475	59·3	57·9	·95	·511	63·3	52·3	11·0	10, 10, 10	E, E by N, WSW.	·166
„ 24	29·796	65·4	51·9	·64	·625	71·6	54·8	16·8	4, 3, 3	WSW, NW by W, S by W.	·741
„ 25	30·069	58·4	55·1	·89	·496	67·8	53·6	14·2	8, 9, 2	NNE, ENE, NE by N.	·000
„ 26	30·254	62·3	57·2	·84	·564	72·6	52·4	20·2	10, 2, 1	NE by N, ENE, E by S.	·001
„ 27	...	...	...	...	...	75·7	46·5	29·2	...	...	·000
„ 28	29·826	63·0	61·0	·94	·578	69·3	55·6	13·7	10, 10, 9	SW, SW, WSW.	·043
„ 29	30·030	56·4	46·7	·72	·464	63·6	52·8	10·8	7, 8, 7	NNW, NE, N.	·004
„ 30	30·288	58·5	46·8	·67	·497	66·8	49·3	17·5	2, 4, 3	NW by N, N, NNW.	·000
„ 31	30·168	59·7	55·5	·87	·518	66·0	45·9	20·1	4, 10, 10	W by N, SW, WNW.	·000
Daily Means.	29·841	59·6	52·2	·78	·520	...	...	17·1	...	...	4·342

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—AUGUST, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A. M. 12	*	5	1	13	1	6	11		3	3	9	4	11	7	9	6	7	15	3	1		7	1	6	5	4	1	1	5	4	0	5·3
1		6	2	15	1	4	9	148	1	2	2	5	14	6	7	9	7	14	2	1		4	2	6	4	6	1	2	3	4	1	5·0
2		5	2	12	1	2	7		2	2	1	5	12	6	8	6	7	13	1	1		5	3	8	2	4	1	3	5	3	2	4·6
3		6	3	12	1	4	10		2	1	3	6	5	9	10	8	6	12	2	1		4	3	8	6	3	1	3	8	2	2	5·0
4		8	7	13	1	3	10		1	1	2	3	5	10	14	6	10	13	1	0		6	6	6	9	4	1	1	7	2	3	5·5
5		8	5	10	2	4	10		1	2	2	4	10	11	17	6	9	13	1	1		4	8	8	9	5	1	3	8	4	2	6·0
6		9	5	11	2	6	10		1	1	2	5	15	15	20	8	11	13	2	1		5	8	8	11	5	1	2	9	4	5	7·0
7		14	5	12	4	9	13		1	2	9	9	16	19	22	13	13	15	2	3		5	10	9	11	5	1	3	10	8	5	8·8
8		13	4	13	2	14	13		2	4	11	13	19	16	20	15	17	16	2	3		5	11	8	14	4	1	4	10	12	7	9·7
9		12	5	13	2	12	13		2	6	15	13	20	20	22	15	17	17	3	3		6	17	8	14	4	2	10	14	13	4	10·8
10		12	9	12	6	13	13	12	5	7	17	17	18	22	24	12	17	15	2		15	7	15	10	10	7	2	14	12	12	*	12·0
11		10	8	13	6	17	9	6	5	9	21	16	22	19	24	16	19	14	6		12	5	15	8	10	7	3	12	14	14		12·0
12	11	14	14	15	6	16	10	10	3	6	17	9	22	20	24	17	16	12	4		8	5	12	9	9	8	3	14	9	10		11·5
P. M. 1	12	16	11	12	9	20	13	9	4	5	17	15	21	13	20	19	16	13	2		12	5	9	8	11	6	4	17	10	9		11·7
2	11	18	8	10	6	20		10	4	10	15	15	21	12	20	19	20	10	4		13	5	11	7	7	5	6	16	12	6		11·5
3	11	16	14	11	7	17		8	3	15	15	15	21	11	20	15	23	9	4		12	3	8	4	15	3	7	16	9	6		11·4
4	11	7	9	10	7	20		8	9	14	18	16	20	12	20	18	20	9	5		10	2	3	9	13	6	7	14	10	5		11·1
5	13	4	9	9	5	18		7	9	6	18	12	17	9	20	14	17	7	5		7	1	5	9	10	6	7	10	7	2		9·4
6	10	4	10	3	1	13		3	6	3	18	12	14	9	19	11	18	4	5		12	7	5	6	7	5	2	11	5	1		8·0
7	8	4	10	2	1	13		3	7	5	16	10	9	7	16	11	16	2	4		11	3	4	4	7	5	1	9	2	1		6·8
8	9	3	13	1	8	13		1	4	2	15	5	7	7	15	9	17	2	2		7	2	3	3	6	2	1	7	4	2		6·1
9	7	4	13	2	8	13		1	5	6	10	7	7	5	13	10	19	3	2		5	2	3	2	7	2	2	5	4	2		6·0
10	10	1	14	2	5	11		2	3	5	8	11	11	6	13	10	17	2	2		5	2	5	4	5	1	2	5	4	2		6·0
11	7	1	13	1	6	11		1	3	8	6	10	8	5	8	9	17	2	3		3	2	5	4	5	1	1	5	5	3		5·5
12																																
Total Daily Movement.	120	200	194	227	98	279	380		86	125	267	237	345	276	405	282	356	245	69	357		102	172	161	207	108	59	187	186	128		8·2

* Anemometer clock out of order.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Tension of Vapour.	Relative Humidity.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°	inch.		°	°	°	0—10		inches.
Sept. 1	30·118	60·7	48·0	·535	·65	69·7	55·3	14·4	7, 2, 2	WNW, W, W by N.	0·000
„ 2	30·161	69·3	56·1	·710	·65	77·4	55·9	21·5	7, 4, 2	NW by N, NW, NW.	·000
„ 3	...	...	...	...	...	74·8	55·5	19·3	...	... ...	·000
„ 4	30·109	69·5	59·9	·715	·73	77·8	53·3	24·5	0, 5, 2	—, S by W, WSW.	·000
„ 5	30·142	66·8	57·2	·654	·73	73·9	52·7	21·2	6, 2, 4	SW by W, SE, WSW.	·000
„ 6	30·128	66·0	58·4	·638	·78	74·7	51·3	23·4	0, 2, 0	W by S, SW, SW.	·000
„ 7	30·020	70·2	62·7	·731	·78	79·6	54·4	25·2	0, 1, 3	SW, S, SW.	·000
„ 8	29·914	72·9	61·6	·798	·69	80·8	54·7	26·1	0, 1, 0	SW, —, SW by W.	·000
„ 9	30·075	63·4	53·9	·585	·73	71·5	59·5	12·0	1, 3, 5	SW by S, SW, SW by S.	·115
„ 10	...	...	...	...	...	73·9	58·2	15·7	...	... ...	·000
„ 11	30·312	66·4	60·1	·647	·81	73·8	63·1	10·7	10, 7, 8	WSW, SW by W, W by S.	·000
„ 12	30·398	66·3	57·6	·644	·75	74·3	57·5	16·8	7, 6, 7	—, —, —,	·000
„ 13	30·295	68·6	58·6	·694	·72	76·8	57·8	19·0	8, 0, 0	SW by S, SW by S, —.	·000
„ 14	30·239	68·1	53·9	·683	·62	77·4	51·1	26·3	0, 0, 0	E, E by S, SE by E.	·000
„ 15	30·169	72·2	54·0	·780	·55	80·7	57·0	23·7	0, 0, 0	SSE, SE by S, SE.	·000
„ 16	30·137	69·6	60·8	.717	·75	79·8	53·5	26·3	7, 4, 8	W by N, S, —.	·000
„ 17	...	...	...	...	...	74·5	56·0	18·5	...	... ...	·000
„ 18	30·413	65·0	55·6	·617	·73	73·7	50·7	23·0	0, 2, 0	—, NE by E, NE.	·000
„ 19	30·360	62·3	56·7	·564	·83	72·3	50·4	21·9	6, 2, 0	—, E by N, ENE.	·000
„ 20	30·089	65·7	57·1	·631	·75	76·4	51·6	24·8	3, 0, 0	—, SW, S by W.	·000
„ 21	30·206	54·9	50·8	·441	·87	62·0	53·2	8·8	10, 7, 9	NNE, NE by N, NE by N.	·350
„ 22	30·360	56·2	47·6	·460	·75	63·2	53·6	9·6	1, 7, 3	NE, NE by N, NE.	·003
„ 23	30·451	56·9	47·6	·471	·73	64·3	39·5	24·8	2, 1, 2	E by N, NE by E, NE by E.	·000
„ 24	...	...	...	...	...	67·7	52·6	15·1	...	... ...	·000
„ 25	30·377	60·5	49·7	·532	·69	71·6	47·0	24·6	6, 0, 0	ENE, E by N, E by N.	·000
„ 26	30·220	63·6	50·1	·589	·64	75·3	49·8	25·5	4, 0, 0	E, SE, E by N.	·000
„ 27	30·084	64·8	49·2	·613	·59	76·2	44·8	31·4	5, 0, 3	NNE, E by N, E by S.	·000
„ 28	30·176	63·4	51·4	·585	·67	69·0	42·7	26·3	0, 0, 7	NNE, NE by N, NE by N.	·000
„ 29	30·203	56.6	51·3	·467	·83	64·1	46·6	17·5	10, 7, 8	NE by E, ENE, E by N.	·000
„ 30	30·087	56·6	50·7	·467	·82	64·9	47·6	17·3	3, 4, 9	NE, ENE, E.	·000
Daily Means.	30·201	64·5	54·6	·614	·72	...	...	20·5	...		0·468

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPTEMBER, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
12	*	*	*	*	*	*	*	*	8	11	10	2	2	1	4	2	3	1	1	2	2	9	2	10	5	4	4	1	8	5	4·4
A.M. 1									5	8	10	2	3	1	2	2	1	1	2	2	4	10	2	11	5	1	4	2	7	4	4·0
2									6	8	10	1	4	1	3	2	1	1	0	3	9	10	1	9	5	3	3	2	3	3	4·0
3									7	6	11	1	3	0	4	2	1	1	0	3	7	7	1	9	3	3	2	1	2	1	3·4
4									5	8	10	1	3	1	4	2	3	2	2	7	6	10	1	9	3	6	2	2	2	1	4·1
5									5	6	8	1	2	1	3	1	3	2	1	7	7	11	2	12	5	9	2	2	3	1	4·3
6									8	7	10	2	1	1	3	3	1	1	1	3	10	10	4	14	8	10	3	2	2	3	4·9
7									8	7	9	1	2	1	5	3	5	3	2	2	10	13	2	16	8	6	2	4	3	6	5·4
8									6	8	12	1	5	2	5	3	6	2	4	3	10	10	4	17	4	3	3	4	5	9	5·7
9									12	8	8	3	5	1	7	2	8	3	3	2	12	9	11	14	2	9	4	9	10	10	6·9
10									12	20	8	5	4	12	8	5	10	2	13	3	15	12	14	16	8	10	5	10	10	11	9·7
11									12	11	22	7	3	8	11	9	7	10	5	14	6	14	13	13	19	14	12	7	10	10	10·7
12								12	15	13	18	10	4	8	11	13	7	7	6	15	9	18	17	14	20	18	15	13	12	14	11	12·5
P.M. 1								17	14	17	10	2	7	11	13	7	8	7	15	13	14	13	16	17	20	15	18	11	14	11	12·6
2								18	15	19	11	4	6	12	12	6	8	7	16	11	15	15	16	18	20	12	18	11	15	10	12·8
3								18	15	17	9	7	5	13	11	4	8	6	17	13	17	8	15	17	23	12	13	9	13	9	12·1
4								17	16	19	11	4	4	8	10	6	9	7	14	13	15	7	13	18	18	15	10	6	13	8	11·4
5								12	14	17	10	3	4	12	8	4	5	5	11	6	10	7	9	12	13	9	8	7	6	7	8·6
6								14	12	15	7	4	6	8	4	7	2	6	13	3	12	6	5	10	10	8	7	10	3	8	7·8
7								11	13	14	7	6	4	11	2	6	1	6	10	5	10	6	6	10	14	9	7	10	3	7	7·7
8								9	12	14	4	1	2	10	4	3	4	5	10	5	12	4	9	10	9	5	2	9	2	3	6·4
9								8	12	13	4	2	0	6	5	3	3	4	8	3	10	4	6	10	9	3	1	10	2	2	5·6
10								6	11	12	3	2	2	7	3	2	2	2	5	3	9	3	7	8	7	3	2	12	2	5	5·1
11								6	11	8	4	1	0	5	3	1	2	1	2	2	7	2	9	7	3	4	1	8	3	5	4·1
12																															
Total Daily Movement.								163	251	302	203	63	90	147	145	90	111	86	179	129	255	216	182	313	234	186	141	164	155	150	7·3

* Anemometer clock undergoing repair.

OPINIONS ON EPIDEMICS AND EPIZOOTICS.

In our September number we published a paper on the "Cattle Plague and Scientific Investigation," since which, up to the date of appointing a Royal Commission, at the beginning of October, the Government has indulged in much restrictive legislation, without doing anything to test the accuracy of the theories which its veterinary advisers have propounded. We believe that the Privy Council have collected a vast quantity of information of a miscellaneous sort; but one obvious duty of that body, from the commencement of its action in reference to the cattle plague, was to organize an inquiry into the probable origin of the disorder. If it could be proved to be simply and purely an importation from Russia, and only to appear in this country after germs of the disease had been distributed through the agency of imported animals, and if it could be further proved that restrictive measures could prevent its spread, then the only limit to such measures ought to be the practicability of their execution. This theory is acted upon in some parts of the Continent, where the medical authorities appear to know as little about the matter as our own, and where despotic principles of Government preclude all consideration of individual liberty and right. The Earl of Clarendon, in a speech at Watford, after alluding to the restrictive measures which the Privy Council was trying to enforce, said, "I own that if we had lived in a despotic country very different measures would have been taken. Every suspected district would have had a cordon of soldiers placed round it, every animal would have been killed, and every man suspected of violating the regulations would have been put into prison. So stringent are the regulations in Germany, that only a few days ago a stuffed wolf was prevented from crossing the frontier, for fear of spreading the contagion!" This is the sort of proceeding which the English Government is invited to adopt by its veterinary advisers, and it only stops short of such monstrous absurdities because the temper of the people would not allow them to be carried out. Well might Sir E. Bulwer Lytton exclaim, "It is not by indiscriminate slaughter, it is not by adding famine to pestilence, that a Government can be hailed as our protector, or science received as our guide."

If the reader will refer to our previous article in the September number he may see the strong resemblance between the notions now entertained by ultra-contagionists, and partially adopted by the Government, and those notions concerning cholera, which raged like a plague, amongst the College of Physicians in 1831. Professor Simonds, the Government

adviser, is an ultra-contagionist, but the most violent and unphilosophical of the school is Professor Gamgee, whose assertions are so reckless, and whose statements are so extravagant, as to remove him from the category of calm scientific inquirers. He makes contagion a hobby, and he rides it to death. Dr. Lankester was imprudent enough, at the Social Science Congress, to support the Gamgee hypothesis, and to indulge in a general theory of contagious disorders; and he put, in perhaps the most scientific form such notions admit of, the current belief of those who think diseases can be suppressed by orders of the Privy Council, Acts of Parliament, and police. The learned doctor condemns an imaginary doctrine that diseases have "a spontaneous origin in dirt," and he thus proceeds to develop his own views:—"Take," he says, "for example, the small-pox. In order to propagate this disease, there must be, first, the poison matter from a small-pox pustule; secondly, a medium of conveyance—either the point of a lancet, or an atmosphere to convey the poisonous germs; and thirdly, there must be a person predisposed to take it."

Now in this brief paragraph we have a succession of positive assertions, some of which cannot be proved. We pass over for the moment the question of whether they are true or not. If true, they still exist only as *conjectures*, and require the verification which full and careful inquiry alone can give. If no case of small-pox can occur without its being excited by the specific poison found in a small-pox pustule, either the laws of nature must have changed, or a specific disease of small-pox must have been created and sent perfect into the world at some past and unknown time. We have heard of a Professor who is of opinion that species of diseases were created, as well as species of animals, and that all existing diseases, and all existing animals, are lineal descendants, with little variation from the primitive individual specimen. Dr. Lankester does not tell us, in so many words, that he shares this extraordinary faith; but his dictum amounts implicitly to this: that all past small-pox, all now existing, and all that is to come, was, is, and will be the progeny and descendant of a primitive specially-created case.

We repeat that we do not now discuss whether this theory be true or false; but we are justified in saying that it is not proved, and that those who hold it are not entitled to speak of it as if it were an ascertained fact.

It is probable or possible that the atmosphere may convey the germs of small-pox, as Dr. Lankester declares; but this again is not known. In the case of vaccination or inoculation, the lancet of the practitioner conveys into the blood of the patient certain corpuscles or cells of morbific matter in an

active state, but whether such cells,* or any portion of them, floating about in the air, and taken into the lungs, or swallowed, or permitted to adhere to the skin, is a real cause of the propagation of small-pox, no microscopist has yet ascertained.

The probability of a scientific theory in any given state of knowledge does not offer the slightest excuse for abstaining from a rigid process of inquiry and verification, and those accurate thinkers who consider Dr. Lankester's hypothesis may be right, will not fail to perceive the want of decisive evidence to support it.

When Dr. Lankester asserts that small-pox can be communicated to suitable individuals by the process of inoculation, he states a fact of which the proof is abundant; but when he takes small-pox as a type of epidemic diseases, and affirms that they can *only* arise by the action of specific poisons, he oversteps the limits of that which is known, and by implication affirms divers theories open to doubt. We have already shown that such a philosophy virtually affirms the original creation of specific diseases, and it also affirms other theories which, if less startling, ought not to be accepted lightly. In a natural and healthy condition we find a continual formation of corpuscles, or cells, and such formations are by no means sharply distinguished from all the products of disease. Causes, such as temperature, moisture, dryness, the presence of putrefying matter introduced into the system from extraneous sources, *may* determine the production of morbid cells by simple variation, from healthy cells, and without any hereditary descent from other morbid cells of any particular kind. This possibility is denied by those who account for diseases by presuming them to result exclusively from *specific poisons*, themselves the product of previous disease of the same species.

We do not offer any opinion as to the extent to which physical and chemical agencies can modify healthy actions, so as to convert them into morbid actions. No one will deny that such an influence may be exerted to a large extent, and no one is entitled to lay down any limits of such action, except those which result from a rigid application of reasoning to a sufficient group of ascertained facts.

In the present state of science a certain class of diseases are not unreasonably supposed to result from something like an action of fermentation, and are hence called *zymotic*. Now, the researches of microscopists, and especially of M. Pasteur, lead to the belief that very minute organisms, more or less

* In the wide sense now given to the term "cell," it may be used without expressing any precise idea of its structure.

resembling yeast, and many of them taking the beaded, or bacterium form, are capable of setting up a variety of fermentations, each developing particular products. M. Davaine has apparently traced a splenic disease in sheep and other animals to an organism of this sort, and the counter experiments seem to show, not that he was wrong, but that his opponents were not operating with the particular organism of which he spoke. Any small independent body, whether having distinct walls or not, which contains or consists wholly or partly of germinal matter, capable, under appropriate conditions, of multiplying by reproduction, may be conveniently called a cell. Such cells may be able to live and multiply in more forms than one. Indeed, as we proceed downwards in the chain of life, the tendency to variation appears decidedly to increase. If, therefore, it is thought probable that zymotic disorders can arise from cells of a particular sort floating in the atmosphere, we should not be justified in asserting that wherever and whenever such cells thrive and germinate in a living being, they must produce one constant type of disease. The proof that a small-pox cell, taken from a pustule, and introduced into the blood of a fit subject, reproduces in him the same disease of small-pox, is not tantamount to a proof that germs from small-pox cells, if such exist, floating for an indefinite time in the air, must either reproduce small-pox, or exert no morbid action at all. We have no proof that germs of disease admit of no variation in their development, whatever may be the conditions under which they are placed. We neither affirm nor deny the accuracy of different hypotheses; our object is to explain, and, if possible, to enforce something like scientific accuracy in reasoning upon these subjects, and to put our readers upon their guard against the pervading error of considering things proved that in reality are only surmised.

In reference to those opinions concerning the cattle disease which bear a strong family likeness to similar opinions concerning other diseases, now known to have been nothing better than the offspring of fear and superstition—it is necessary to determine the special kind of test to which they should be subjected. In the first place, the importation theory should be cautiously sifted. In every case in which it is assumed that the disease was caught through contagion, proof should be demanded, first, that the alleged circumstances under which the contagion is stated to have operated did really exist; and, secondly, that such circumstances were really competent to produce the effect. In one case reported in the daily papers, the only mode of supporting the importation and contagion theory was by presuming that the poison matter *might* have

been dropped by some animals on a public road, and *might* have been picked up by some other animals ten days afterwards. In other instances it has been presumed that small quantities of the poison may have been carried away by the boots of a grazier, by the skin of a sheep dog, or the clothes of anybody who went within a few yards of a sick cow, and may by some sort of contact with healthy animals have infected them. Now, no presumption, however well founded, that the cattle disease is highly contagious, can make it reasonable to impute to it such a wonderful degree of contagious power, without multiplied observation and judicious experiment, testing and verifying every particular assertion. A certain number of cases seem to favour the importation theory; but even these have not been critically examined. In a multitude of other cases the importation theory is not evidenced at all. It *may* be true, but it has been assumed to be so, first, because it was the fashion of the hour; and, secondly, because particular doctors did not know how else to account for its appearance, and felt a professional dislike to frankly confessing that they knew no more about the matter than the cows themselves.

Those familiar with microscopic inquiries will place no limits to the smallness of the portions of matter that may generate disease. A single bacterium, of the sort described by M. Davaine, obtaining access to the blood of a living animal, appears capable of growth and reproduction, to such an extent as to occasion its death in a few days. The size of such a bacterium and its weight are both infinitesimal, and other germs of disease may be equally small or much smaller. But if it be admitted that M. Davaine's bacteriums cause splenic disease, millions of them might fly about in the air, or attach themselves to cattle, or be swallowed, or inhaled before one contrived to get into the circulatory system in contact with corpuscles of blood. The ultra-contagionists have to show not only the presence and diffusion of their poisons, but also the manner in which such poisons can make an effective entry into the system. Many poisons are only dangerous when administered in a particular way.

The Privy Council has been the death of a great number of animals which might otherwise have been cured. At the Sanatorium meeting, Mr. Guerrier (described as an extensive cattle salesman) stated that a cargo of 108 foreign animals arrived at Harwich, and one of them was suffering from the malady and died. The whole of the remainder were perfectly healthy, and were declared so by the inspector. These were killed and sent to London, while ten others consigned to another party were kept in quarantine and remained healthy. These facts, as Mr. Guerrier said, clearly showed either that

the disease of which the one died was not the rinderpest, or else that the rinderpest was not so infectious as it was represented. It is very important that we should be able to form an estimate of the number of curable animals that have died of the Privy Council, and of the loss occasioned by stopping cattle fairs, etc. Let us also study the other side of the account, and try to find out what the so-called preventive measures have been really worth. That they cannot, under the most favourable probabilities, be estimated as worth much, is rendered probable by some Dutch statistics supplied by Mr. Caird, according to which, out of 3319 animals attacked, 1169 died, 674 were slaughtered, 717 recovered, and the remainder were under treatment. "In proportion," he says, "to the whole number of cattle in the country less than three in every thousand have been attacked by the disease, and not two in a thousand have perished." If our Privy Council and the veterinary surgeons have prevented some cattle from being infected, they have killed numbers which might, according to Dutch experience, have been cured. On which side does the balance lie?

Many people think that they solve the practical difficulty of these cases by violently adopting measures called precautions, on the plea that "it is best to be on the safe side." There may not, however, be a "safe side," but simply a choice of evils. The Government restriction mode of procedure infallibly does much harm, and all that its best friends can expect is to demonstrate that the harm thus done is more than counterbalanced by the good achieved in arresting the disease. We are yet without data from which we can compute either the amount of mischief occasioned, or prevented by Privy Council action. The former is certainly very great, and unless the latter is greater, the balance will be on the wrong side. At a meeting of the Sanatorium Committee of the Corporation of London, which took place on the 13th of October, Mr. Game mentioned a case in which some cows were condemned by the Government inspector, but as the slaughterman could not come at the moment, medical means were adopted and the animals cured instead of killed. Mr. Rudkin mentioned another case in which thirty cows were condemned, and after that twenty-four of them were cured. Mr. Caird likewise tells that in Holland it is found that under a "rational treatment" 25 per cent. of the cows afflicted with the rinderpest have recovered, and he adds, "The most successful treatment is said to have been by homœopathy. This has been practised by two Belgian practitioners, who volunteered their services to the Dutch government. By them 50 per cent. of the animals which had been sick had been cured, and out of

148 sound animals treated by them with preventive medicines, and placed in contact with diseased cattle, not more than four had taken the disease.*

Such statements tend to the belief that the greatest attention ought to be paid to any fact that can throw light upon the causes that have facilitated the attack of the disease in some cases, and prevented it in others. Hitherto the doctors have not obtained the slightest clue to why some cows on a farm have been infected and died, while others, apparently similarly circumstanced, have escaped. It has been the custom to make the most of every case of attack, and to pay little attention to the instances in which the poison, whatever it may be, failed to operate.

Let us suppose for one moment that the violent hypotheses concerning the cattle disease were accepted, and that the continental plan of destroying all cattle found in the vicinity of an infected cow, and of cutting off their attendants from all intercourse with the outer world, except what can take place by periodically tossing them something to eat, was admitted to be the best. It would follow that the only plan of staying the pestilence would be one of wholesale destruction of animals, and quarantine imprisonment of all human beings who had come near them. But why restrict this benevolent action to cattle? If a man catches a disease of this class, and every hour that he lives he scatters far and wide through the atmosphere germs of poison that must kill scores, or it may be thousands, what ought to be done with him? A hospital would evidently be a mistake, and leaving him at home still worse. If he and all his neighbours are not to be killed like the cows, which pseudo-science might recommend, at any rate all infected and suspected persons ought to be securely bottled up in some receptacle capable of imprisoning the disease. Will our glass manufacturers turn their attention to Gamgee-Lankester bottles, with admirably-ground stoppers, in which the afflicted may be immured?

One of the beneficial results of modern science has been the diminution of fear in the treatment of disease. It has been shown that if persons sick of contagious disorders can be placed under healthy conditions of ventilation, cleanliness, light, etc., attending upon them does not involve serious risk. In former ages the advent of the plague produced an epidemic terror as bad as, or worse than the disease, and to this day, in the East a similar state of mind prevails. Even at Smyrna, during the recent outbreak of cholera, hotel keepers refused to receive guests, all the people, doctors included, were afraid to attend the sick, and misery was multiplied a hundredfold, because terror assumed unrestrained command. It is to this

* Letter to the *Times*, 17th Oct.

condition the ultra-contagionist doctors would bring us back, and if they are the cause of a dangerous epidemic terror, why, on their own theory, should they not be debarred from all intercourse with their fellow men?

Theories of epidemics affect the whole life of a nation, and hence it is of the highest importance to know whether they are right or wrong. In dealing, or attempting to deal, with the cattle disorder the Privy Council most seriously affects great interests, as well as infringes private liberty in a way that can only be excused by an amount of proof of the accuracy of their ideas which certainly does not at present exist. They have thrown the foreign cattle trade into deplorable confusion, and they are obstructing the home trade in a very serious way. We copy the following statistics of the cattle trade from the *Morning Star*:—

"The increase in each class of beasts imported is large and constantly progressive. For the months ended 31st August, 1863, 1864, and 1865, respectively, the numbers of oxen, bulls, and cows imported were 14,279, 18,261, and 27,207; of calves, 6,726, 5,477, and 8,078; of sheep and lambs, 66,610, 67,360, and 105,365; of swine and hogs, 4,132, 11,021, and 15,137. For the eight months ended 31st August, 1863, 1864, and 1865, respectively, the numbers imported were, of oxen, bulls, and cows, 45,361, 82,447, and 119, 323; of calves, 21,863, 29,373, and 35,553; of sheep and lambs, 214,950, 256,694, and 427,439; of swine and hogs, 6,679, 37,630, and 64,559. Mr. Henley's 'drop' he stated at about 138,000 head of cattle imported, but according to the present rate of importation the figures should have been about 160,000 head of oxen, bulls, and cows; and if the other descriptions of live stock be taken into account, the number of heads imported will amount at the present rate to above 860,000 head per annum."

Such a trade as this is a most serious matter in reference to the difficult question of feeding an enormous population, and when in addition to the injury done to the foreign trade we read of cattle fairs being stopped, and learn that arrangements for breeding fresh stock are interrupted to a great extent by Privy Council legislation, it is time to inquire very seriously whether Government intervention is not likely to prove much more mischievous than the disease it is intended to stop. If State meddling raises the price of meat two or three pence in the pound, it will indirectly kill multitudes of human beings, and the survivors may at last have the consolation of learning that the notions of the doctors were founded in mistake.

THE LUNAR MARE SERENITATIS.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We come now to a grey level of very interesting character, as well as peculiarly well situated for study, the *Mare Serenitatis* (lettered E in our map). It is of an approximately circular form, extending 442 miles in a N. and S. direction, and 423 from E. to W.; its longest axis lying from SW. to NE. Some foreshortening of course results from its N. latitude, but not sufficient to distort it materially; the telescopic view, however, gives but little idea of the convexity of so considerable an area upon the comparatively small lunar globe. Its outline is not much indented, and is more distinctly marked out than in the majority of these plains: its circumference, including bays, equals about 1840 miles, three-fourths of which consist of the cliffs of *Hæmus*, *Taurus*, *Caucasus*, and the *Apennines*. Broad passages unite it on the S. with the *Mare Tranquillitatis*, on the N. with the *Lacus Somniorum*, and on the E. with the *Palus Putredinis*. When the *M. Tranquillitatis* and *L. Somniorum* lie with it on the same terminator, it is evidently on a lower level than the other two; and this is confirmed by the circumstance that the slopes of nearly all its mountain borders are much more steep on their inner than their outer sides, and when there is any perceptible difference in the slopes of the low ridges in the interior, it is always in the same direction. This great plain presents in many phases a fine telescopic object, and when the terminator passes through the E. edge, the whole may be seen at once in beautiful projection. I have noticed it thus some hours before quadrature, but, of course, libration makes a material difference in all such epochs. The outer edge, on nearly every side, for a breadth of 28 to 83 miles, shows usually a dark uniform grey, of 1½° to 2° of reflective power. The whole interior, comprising nearly two-thirds of the entire area, exhibits at the Full Moon, according to B. and M., a beautiful clear uniform light green of 3°, which, as they state, was remarked neither by Schröter nor Lohrmann, and which they freely admit may be so much matter of "personal chromatic equation" (to borrow an expression of later invention), that they should not feel surprise at its not being perceived by others: they are well assured that the contrast between the light of the plain and its border is a difference not merely in degree but in kind; but they allow that it is not easy to be satisfied of it, and that it is chiefly discoverable by comparison with other levels of similar brightness, and only

for two or three days before and after the Full Moon. I have never succeeded in seeing it decidedly green. My attention having been called to the point, I can detect some difference in the tint from that of other plains, but the contrast is not great: I should perhaps call the hue, as it appears to me, a greenish yellow. The boundary between the lighter centre and its deeper fringe is very distinct, especially to the S., where it passes alike over plain and ridge: in other directions it coincides with slight elevations.

The plain is nearly equally divided by an almost straight whitish streak, with a breadth of about 12 or 14 miles, a luminosity of 4° to 4½°, and a direction not much differing from that of the meridian. It becomes less conspicuous as the terminator approaches it, and vanishes entirely before the lunar sunset, exhibiting not the slightest elevation or depression, though concurring in some places with the direction of slight ridges, which Schr. mistook as an indication of height throughout. Our guides remark that in so favourable a position banks of 60 or even 40 feet might be detected, though scarcely capable of delineation; and that every elevation, however insignificant, or of whatever tint, becomes more distinguishable in the immediate vicinity of the terminator; while on the contrary this, and the other streaks in general, comport themselves in the very reverse way; there being not one on the whole lunar surface that is perceptible in that situation.

This beautiful expanse will afford to the observer an excellent opportunity of studying the more familiar characteristics of these grey plains. He will not indeed meet with many of those insulated mountains and craters which give so great a charm to the scenery of the *M. Crisium*, the *M. Imbrium*, and others, nor will he find those roughened tracts which characterize the neighbouring *Lacus Somniorum* and similar regions. But the broad sweep of undisturbed level can scarcely anywhere be studied to greater advantage, and the low ridges which may possibly have a greater significance in selenology than might at first have been supposed, are here very clearly developed. A small bright crater named *Taquet*, between *Menelaus* (15) and the *Promontorium Acherusia* (previously described), is the starting point of the ridge-system of the plain; and we have here an exemplification of a fact to which Schr. has repeatedly invited our attention—that these low banks form lines of communication between objects of more apparent importance. Though in many of them no such arrangement can be made out, yet the instances are innumerable in which they are found to connect distant craters or headlands, or to serve as the bases of rocks or small hills, much resembling, if so homely an illustration may be permitted, the

subterranean galleries by which the common mole unites his more serious and massive upheavings. Schr. was in fact disposed to refer their origin to the working of an elastic force beneath the surface of the moon, which, in regions where the crust of the globe was of great tenacity, and offered a proportionate resistance, would thus slightly elevate it in making its way laterally till it reached a more penetrable spot, where it would protrude a lofty mountain mass, or explode in a crater. Whatever may be thought of the probability of the explanation, the fact is unquestionable that these ridges generally begin and end, like terrestrial highways, in something of more importance than themselves, and that this is of such continual occurrence in every part of the moon that we can hardly be mistaken in ascribing it to the operation of some general law. In the plain which we are now studying, the most remarkable of these ridges lies not far from its W. side, and in a general sense parallel to it. Including its curvatures it measures nearly 500 miles in length, while it is but 400 or 500 feet high towards its S. extremity, and rises only to 700 feet in one part near its opposite end, its slope never exceeding 10°, and its base of 7 miles, as Schr. observes, giving a proportion of only $\frac{1}{43}$rd for its altitude. In one place it bears a minute crater, precisely where a similar ridge runs into it, in accordance with Schröter's hypothesis. B. and M. have not drawn attention to the very curious appearance which this great *serpent* exhibits near the terminator. This has been well though rudely delineated by its discoverer Schr., who points out its connection with the ring of *Posidonius* at its N. extremity. The student will find it worth watching for, and will notice how its strong dark shadow close to the terminator demonstrates the visibility of very slight elevations in that position. In the E. side of the plain the ridges are less considerable, and B. and M. remark that in no portion of the lunar hemisphere is the terminator of so regular an elliptical curve as when it passes through part of this district.

A good many craters lie scattered throughout the level, but generally of minute dimensions. The most important by far is *Bessel*, which though but 14 miles in diameter, is the most conspicuous object in the interior, lying, not indeed centrally, but far out at sea, and on the brightest part of the long bisecting streak. B. and M. make the depth of its interior 4000 feet below the W. wall, and the height of its E. wall 1600 feet from the plain. Schr. gives a depth of about 3400 feet, but observes that in such minute measures an error of $\frac{1}{9}$ might easily occur; the height of the E. wall he states at 900 feet, with two peaks of 1000 feet, casting a cone of shade at each extremity. I think I have remarked a singular form in the

outline of its shadow. Of smaller craters there are a good many, and Schr. has delineated some not to be found in B. and M. or Lohrm., reckoning up on one occasion twenty-two, though the plain was not fully illuminated. This might in part be due to the superior light and power of his 13-ft. reflector, which had an aperture of 9½ inches;* but it needs no great amount of selenographical experience to be aware how little stress can be laid upon such discrepancies. Yet we must not pass over everything of this kind too inconsiderately, or allow ourselves to form a habit of invariably refusing a less plausible explanation of unknown phænomena. With this error Schr. was certainly noways chargeable; on the contrary, we find him constantly deducing conclusions from premises which others might consider inadequate. Thus, on the occasion referred to, he lays much stress upon the circumstance that instead of two whitish heights and a hollow, with a speck like a minute hill in its centre, which he had formerly noted towards the middle of the plain, with his 7-ft. reflector made by Sir W. Herschel, and which he had never subsequently seen with any instrument, or under any angle of illumination, during upwards of seven years, he now found two distinct bright small craters: while at the same time he perceived two other small craters, hitherto unknown, in a place where he ought to have noticed them in two observations nearly five years before: he found the place of a little crater, recorded more than seven years before, occupied by a grey spot like a longish low hill; and in another region could not identify some well-known ridges amidst an aspect of general confusion. From all this he inferred of certainty of some variation in the lunar atmosphere, induced by natural or possibly even artificial causes, connected with the agency of living creatures. We may perhaps be disinclined to follow his line of argument to its full extent. We may think that he did not always sufficiently bear in mind the spirit of his own important remark, that "the longer and more frequently one and the same small spot is observed, so much the more we discover." We may consider it desirable to wait for a fuller and a more rigidly convassed collection of facts before we attempt to make them the basis of a generalization. But we should not therefore be acting discreetly in rejecting any result of careful observation, however contrary it may seem to our preconceived opinions; and the history of science may teach us, that of the two extremes, the visionary is more likely than the sceptic to push forward the boundaries of knowledge.

Many of the ridges which intersect the plain, and which Schr. compares to the veins of animal or vegetable substances,

* Probably of the Calenberg scale, equal to a little more than nine English inches.

are very low; but close to the terminator, where the sun is only 1° or 2° high, he found that they cast measurable shadows, especially from their more rapid slopes. The faintness, however, of the terminator rendered it difficult to make them out well; even a keen eye requires practice to distinguish them; and years elapsed before he was able to measure the length of the shadow, and the distance of the ridge, with complete certainty. The effect of "penumbra"* is sensibly felt here, and should be adverted to by the student. It is evident that the true terminator, or circle, dividing the lunar globe into two equal hemispheres, must be found where the centre of the sun is in the lunar horizon. But the upper hemisphere of the sun casts a considerable amount of light beyond that line, gradually decreasing till the whole solar globe is invisible, but, owing to the variety or absence of a lunar atmosphere, retaining a perceptible illuminating power to the last; and hence the true terminator is carried forward beyond the hemisphere by a "penumbra," or border of about 8″, of continually increasing duskiness, which may be traced on level ground by an experienced eye. A similar effect may sometimes be noticed in softening the brightness of mountain tops at a distance beyond the terminator, and the existence of this penumbra is occasionally apparent in other situations, and under higher angles of illumination. Most of the shadow on the moon is indeed black midnight, from the absence of atmospheric diffusion; but a practised eye will occasionally detect an incomplete illumination, derived from the partial visibility of the solar globe. In some instances no doubt a grey tint, as seen from the distance of the earth, may result from the presence of innumerable and undistinguishable specks of black shadow thickly scattered over a roughened surface; but in other cases we are able to trace the half-shadow, or rather half-light, resulting from the effect of a rising or setting sun; and Schr. thought he could perceive a want of sharpness at the points of long outstretched shadows arising from this cause.

The ridges of the *M. Serenitatis*, as the illumination increases, are converted into white streaks, and the other irregularities of surface become luminous, so that on one occasion, when he speaks of the magnificence of the scene, he could

* This term, in its strict optical meaning, would signify the whole space illuminated by anything less than the entire disc of the sun, instead of, as here, the portion enlightened by his upper visible hemisphere, in advance of the true terminator. The *whole* optical penumbra on the moon subtends about 16″ at the distance of the earth, but of course only its darker portion is perceptible, for the same reason that in solar eclipses the diminution of light is not sensible till a great part of the disc is obscured; and the extent of this visible portion will no doubt vary according to the power of the telescope and the sensitiveness of the eye.

count about thirty spots of light in the grey level, and at another time, by the aid of his great 27-ft. reflector, he was able to distinguish fifty-nine or sixty of various magnitudes, and probably might have detected still more. Such variations of aspect he was disposed to refer to modifications in the lunar atmosphere, and he considered them as forming a striking analogy to the occasional freckled aspect of the *M. Crisium*, mentioned in its place (INT. OBS. v. 203), the reality of which has been confirmed by modern observations, without the slightest clue being obtained to any more probable explanation.

DOUBLE STARS.

We shall revert to the diagram given in our last number for the purpose of identifying some objects contained within its area, and as yet undescribed. One is

150. 307 P. XIX. *Aquilæ*. 15″. 307°·8. 7 and 13. Lucid white and blue (1834·63). This is chiefly inserted as a test for light, in which respect it will be found convenient for moderate-sized telescopes. To me it is very easy. A seems to be pale orange (1865·65) There is a minute closer pair *p*, a little *s*, in the field. It will be found just following *o*, a 5-mag. star, about $1\frac{1}{2}°$ *n* of *Al·Tair*.

151. Double star in *Sagitta*. Between γ and θ of this asterism we shall find η, a 6-mag. yellow star. At some little distance, perhaps 35′ or 36′, from this, *sf*, but more *f* than *s*, lies a pretty little open white 8-mag. pair, not mentioned by Admiral Smyth* or Σ (for whom it was probably too wide). When viewed in a large field, its aspect seems to bespeak physical connection. It is closely associated with a 12-mag. star, forming with it a right-angled triangle. Another less interesting double star occurs nearer η, *sp*, but more *s* than *p*.

The whole area comprised in our diagram is of such richness as well to repay the trouble of sweeping over with a low magnifier. A beautiful region may be pointed out, before we leave it, marked by two small stars (6 mag.) in the engraving between 6 and 8 *Anseris*, and 2 and 3 *Sagittæ*, but nearer to the latter. It is visible as a group to the naked eye, and is a fine object of a rudely triangular form in the finder, but is too wide for the telescope. The *f* star of the two southernmost

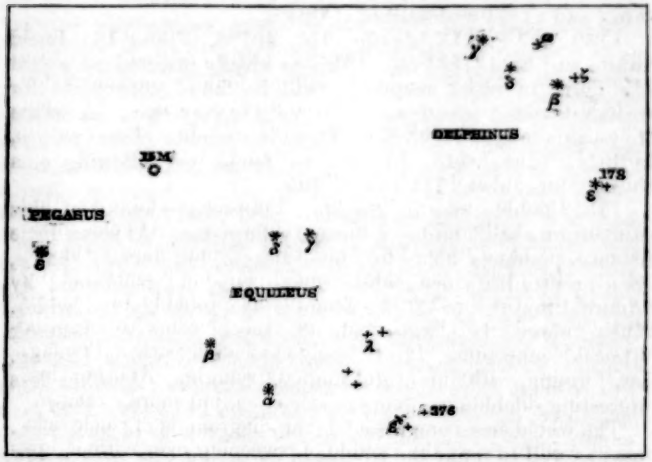
* On the first recurrence of the name of this illustrious astronomer, hydrographer, and antiquarian, after his departure from among us, it may be permitted to me to give expression to the regret which all scientific readers of these pages must feel, at the loss of one so distinguished alike by the variety of his attainments and his eminence in each of them.

"Nihil quod tetigit non ornavit."

Personally, I might add more; this very brief and imperfect tribute is due from all who love the objects of his most successful study.

among the brighter components, which is 5 *Anseris* (its companion being 4), is of a fine orange hue, verging to scarlet; it has a minute 12-mag. attendant *f*, a little *n*, and a brighter and more distant one *n* a little *p*. This great group is preceded by a minute triangle, 8½ and 9 mags., with a 10-mag. star in its interior.

We have at present no further reference to make to our previous diagram, but we shall now introduce another to aid us in the examination of an adjacent and not dissimilar region, which, though not illuminated by any very conspicuous star, is possessed of considerable interest. Like the preceding one, from its contiguity to the Galaxy, it is so rich in the smaller classes of stars that merely sweeping over it with an ordinary



finder will give us some little idea of the astonishing magnificence and variety of the heavens, while the further we are enabled to penetrate it the more we shall be impressed with the incomprehensible greatness of the Creator. We begin with the constellation *Delphinus*. Here a very striking pair, one of the most beautiful of its kind in our skies, γ, has already appeared as No. 63 of our list (Vol. II. p. 373), but it may be again adverted to, on account of the discrepancy between Sm.'s magnitude of B, = 7, and that assigned by Σ, who makes it 5, it being borne in mind that their constant difference would not be apparent in this part of their respective scales. To my own eye, Sm.'s rating certainly appears very

small. I should have thought it not lower than 6. It will serve also as a pointer to the following:—

152. Σ 2725. In the same field, if the power is low, with *γ Delphini*, lying *s*, a little *p*, we find a very pretty little pair, not mentioned by Sm., but designated as above, and described as 4″·237. 358°·05. 7·3 and 8 of Σ's, or about 8 and 8½ of Sm.'s scale. White and ash-coloured. The Russian astronomer thought a slow motion in angle probable.

The other bright stars offer nothing very remarkable, but between *β* and *ζ*, both yellow, the former the deeper, we should look for a remarkable little triangle of 8-mag. stars, whose very aspect seems to bespeak their mutual connection. It would be a curious though troublesome task to ascertain from the calculus of probabilities, how many chances there are against a mere perspective equality of brightness in three objects within so small a compass. If we are studying colours, we may sweep for two stars, one about 1¾° *n* of *γ*, a little *p*, 7 mag., pale red; another 1¾° *p* the last, a very few minutes *n*, fine orange.

We next find readily, by means of *ε*, which it closely precedes—

153. 178 P. XX. *Delphini* (marked simply 178 in diagram). 14″·3. 256°·1. 7½ and 8. Both white. To these, Sm. adds a 16-mag. companion, 20″, 125°, visible only by evanescent glimpses under clock-work with his 5-$\frac{9}{10}$ inch object-glass; and Dawes a 9-mag., discovered by him as an elongation of 8, 1840·82, and confirmed by Sm., 1842·58, when he estimated the distance at 0″·7. As it had been unperceived by Σ in four measurements, our great astronomer was disposed to assume the binary character of the pair. I have found it a very difficult object with 5½ inches, but I think it appears elongated; at least it does not look exactly like its companion.

We proceed now to the little asterism *Equuleus*, an unaccountably shaped figure, said to be due to Hipparchus. What may have induced the venerable astronomer to insert the head and neck only of an animal is now past inquiry. There is no brilliant star here, *a*, the *lucida*, attaining only 4 mag. Three pairs, however, will well reward our search. We begin with the easiest to find, which is visible on any clear night to the naked eye as a minute but solitary and easily recognized star.

154. *ε Equulei*. 11″·2. 78°·1. 5½ and 7½. Pale yellow and bluish lilac. The pair is pretty, but it is converted into a most interesting group by the "duplicity" of A, discovered by Σ as an object of extreme difficulty, his measures giving 0″·35 and 294°·04 (1835·67). Only three years after, Sm. found it more open, 0″·5 and 290° (1838·83). Secchi's mean is 0″·819, 287°·44 (1855·876). Knott at the present time

(1865·68) finds 1″·075, 288°·08, establishing the binary character ascribed to it by Sm. His measures also of A C (or the wide pair) tend to confirm Secchi's opinion that there is angular motion in that quarter also, and in the same direction. Should this indeed be proved hereafter to be a mutually connected system of three revolving suns, what a wonderful instance it will exhibit of an arrangement so wholly unlike our own, and so superior in magnificence, if not comparatively diminutive in size; yet governed, as far as we can ascertain, by the same unchanging law. In their present position A and B form an exquisite pair. Secchi (who ascribes to them, by the way, a yellow and bluish tint) calls them "the most beautiful of beautiful objects." They answer admirably as a test for moderate-sized achromatics, with the convenience, for observers unprovided with circles, of being immediately identified by the presence of C. I can just separate them with a power of 170, and there is a black division with 212.

ϵ *Equulei* will be noted as one of three stars in the finder—those represented (but of course in a reversed position) in the diagram. The central one, which is also the smallest, offers nothing noticeable except its orange hue; but the further one lying *np* from ϵ must be examined more closely. It is—

155. 376 P. XX. *Equulei*. 1″·8. 286°·8. 6 and 8. Orange and purple. I fancied B pale tawny, 1865·73: but this is probably an instance of the singular uncertainty attending these colours, at least to some eyes, which I have mentioned elsewhere. Knott sees it lilac. Sm. calls this "an exquisite pair." The very accordant measures of Σ, Secchi, and Knott at distant epochs, give about 2″·13 as the distance, which must have accidentally been undermeasured by Sm. It is Σ 2375.

156. λ *Equulei* (*alias* 2, *i. e.* of Flamsteed's notation). 2″·6. 225°·6. 6 and 6½. Both white. This "lovely object," which is stationary, will be found with little difficulty from the diagram. It is somewhat remarkable that the affixer of the Greek letter, whoever he may have been (not, as usual, Bayer, who stops at δ), and Flamsteed should both have noted this star in preference to the brighter one which lies at a few minutes' distance *np*. If there is no suspicion of error here, it might lead to the idea of variable light in the latter star, which has been inserted in the diagram. λ is Σ 2742.

157. δ *Equulei*. 28″·2. 36°·8 (1838·59). 4½ and 11. Topaz and pale sapphire. This object is inserted in consequence of Mr. Knott's observation, that it is interesting from the remarkable change in position and distance, owing to the proper motion of the larger star. His data are 34″·488. 27°·67 (1865·718).

Before leaving this neighbourhood, it may be well to remind any of our readers who may not be acquainted with that eminently beautiful cluster, 15 M, that it lies at only a short distance, and may be readily found by means of δ *Equulei* and ε *Pegasi*, as will appear by the diagram. It has been described as No. 22 of our list, Vol. vi. p. 118.

OCCULTATIONS.

Nov. 4th, δ^2 Tauri, 6-mag., 9h. 58m. to 10h. 37m. 5th, 115 Tauri, 5½-mag., 10h. 8m. to 11h. 8m. 28th, B. A. C. 221, 6-mag., 6h. 11m. to 7h. 16m.

THE SPECTROSCOPE AND THE MICROSCOPE.

Mr. Browning has just completed the construction of an entirely new spectroscope, admirably adapted to microscopic investigations. Several of these instruments were exhibited at the Microscopical Society, on the 11th of October, and explanatory remarks were made upon them by Mr. Slack, to whose microscope one had been adapted, and which he represented as working admirably and with great facility.

Some time ago Mr. Sorby applied a spectroscope to the microscope, using the latter instrument as a telescope, by which the spectra afforded by a transparent object could be viewed. Great credit was due to Mr. Sorby for thus indicating a variation in the method of spectroscope inquiry, and some of his results were very interesting; but it occurred to several scientific men that it would be better to apply the spectroscope to the microscope than the microscope to the spectroscope, and the first important step in this direction was taken by Mr. Huggins, who made a communication on the subject to the Microscopical Society on the 10th of May, 1865. In Mr. Huggins' plan an adjustible slit was placed three or four inches behind the object glass, "behind the slit at its own focal distance is placed an achromatic lens," which transmitted parallel rays to an angular-shaped spectroscope similar to the ordinary kind. Mr. Huggins pointed out in the paper to which we have referred, that "the spectrum of any part of a microscopic object could be examined apart, and also can be compared with the spectra of adjacent portions of the object. In this manner the spectrum of a single blood disk, or the spectrum of the contents of a single cell, can be observed, and any changes in living tissues which cause a modification of the spectrum can be watched and investigated." In the

same paper the application of the instrument to opaque objects was also pointed out, and Mr. Wenham, who stated that he had assisted Mr. Huggins in some of his investigations, said, "We so far differ from Mr. Sorby that we are able to make an analysis of the smallest microscopic object, such as the smallest portion of a blood disk, mounted in the ordinary way. We can get a strong spectrum, and the power of the object-glass gives a better result. . . . . We found some curious results from investigating opaque objects. In all spectrum analysis the difficulty is to get a monochromatic light. Generally we get a spectrum of some sort; but from the surface of many opaque objects the reflected light is perfectly monochromatic."

At the meeting of the Society, at which the preceding remarks were made, Mr. Slack stated that he had tried a direct vision spectroscope made by Mr. Browning for Mr. Gassiot, and that an instrument of this description would be convenient for use with the microscope. Mr. Browning had already turned his attention to this matter, and after many experiments, in some of which we believe Mr. Sorby took part, he devised a compound prism, giving direct vision, and having an amount of dispersion very well adapted for the exhibition of delicate absorption bands.

The new spectroscope for the microscope may be used under the stage, when required; but its most convenient place is that of an ordinary eye-piece. As will be seen from the figure subjoined, it is a very compact piece of apparatus, very ingenious in construction, and consisting of several parts. The prism is contained in a small tube, which can be removed at pleasure. Below the prism is an achromatic eye-piece, having an adjustible slit between the two lenses; the upper lens being furnished with a screw motion to focus the slit. A side slit capable of adjustment admits, when required, a second beam of light from any object whose spectrum it is desired to compare with that of the object placed on the stage of the microscope. This second beam of light strikes against a very small prism suitably placed inside the apparatus, and is reflected up through the compound prism, forming a spectrum in the same field with that obtained from the object on the stage.

Mr. Wenham pointed out the importance of so far modifying Mr. Huggins's plan as to allow any small object to be brought into the field and focussed in a convenient way. In Mr. Browning's plan nothing is easier. The prism is taken off and the slit opened by turning a screw. The apparatus then acts simply as an eye-piece, and a single blood disk may be brought exactly in the middle of the field. The spectroscope slit may then be closed so as to isolate the blood disk from

similar disks on either side of it, and then a small shutter, worked by another screw, diminishes the length of the slit to any extent required, and the blood disk, or other minute object, is seen in a little optical cage, which shuts out the view of other bodies. The prism is then replaced, and if all the adjustments are in order, the absorption bands produced by blood are distinctly seen. We have found it easy to operate in this way with an object-glass as high as Smith and Beck's $\frac{1}{10}$th.

Very important results may arise from Messrs. Huggins's and Wenham's micro-spectroscopy of opaque objects. With a two-thirds or half-inch objective it is easy to get a good spectrum from a portion of blood dried on a card or a bit of glass, and not bigger than a full stop in small print. A similar portion of dried blood may be viewed conveniently with higher powers as a transparent object.

We reserve for another occasion a description of some interesting experiments which will illustrate the kind of inquiry for which the application of the spectroscope to the microscope is adapted. Solutions and fluids of various kinds may be placed in small cells, or, as Mr. Slack pointed out at the Microscopical Society, minute drops of various substances may be placed upon a glass stage and their spectra examined before and after reagents are applied. The small drops required can, as he explained, be handily taken up by glass rods drawn out to the thickness of a needle, and having a little crook at the end. The glass stage should have the bottom ridge turned in at an acute angle, and glass sides, by which means the fluids are prevented from escaping on the stage. Unless very small drops are placed on this glass stage they run down too easily and spoil the experiment.

Mr. Browning deserves great credit for the skill displayed, both in the invention and construction of this new and very elegant spectroscope, which is exceedingly easy to use, though a little complicated to describe.

We append a view of this spectroscope, with a description of the parts, so that our readers will find no difficulty in applying it to their microscopes.

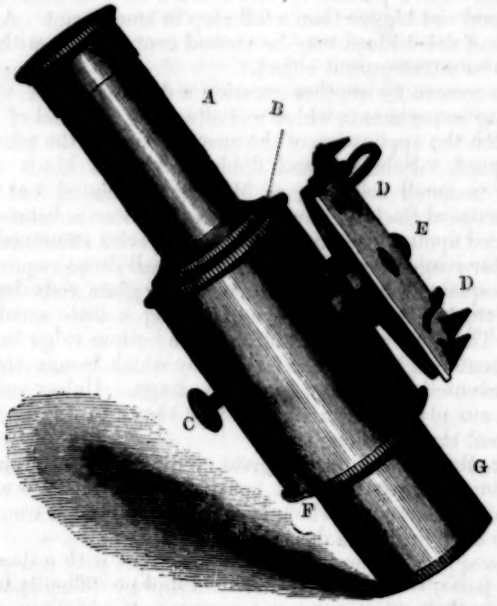
A is a brass tube carrying the compound direct vision prism.

B, a milled head, with screw motion to adjust the focus of the achromatic eye lens.

C, milled head with screw motion to open or shut the slit *vertically*. Another screw at right angles to C, and which from its position could not be shown in the cut, regulates the slit horizontally. This screw has a larger head, and when once recognised cannot be mistaken for the other.

D D, an apparatus for holding small tube, that the spectrum given by its contents may be compared with that from any other object on the stage.

E, square-headed screw, opening and shutting a slit to admit the quantity of light required to form the second spectrum. Light entering the round hole near E, strikes against the right-angled prism which we have mentioned as being placed inside the apparatus, and is reflected up through the slit belonging to the compound prism. If any incandescent object is placed in a suitable position with reference to the round hole, its spectrum will be obtained, and will be seen on looking through it.



F shows the position of the field lens of the eye-piece.

G is a tube made to fit the microscope to which the instrument is applied. To use this instrument insert G, like an eye-piece, in the microscope tube, taking care that the slit at the top of the eye-piece is in the same direction as the slit below the prism. Screw on to the microscope the object-glass required, and place the object whose spectrum is to be viewed on the stage. Illuminate with stage mirror if transparent, with mirror and lieberkuhn and dark well if opaque, or by side

reflector, bull's-eye, etc. Remove A, and open the slit by means of the milled head, not shown in cut, but which is at right angles to D D. When the slit is sufficiently open the rest of the apparatus acts like an ordinary eye-piece, and any object can be focussed in the usual way. Having focussed the object, replace A, and gradually close the slit till a good spectrum is obtained. The spectrum will be much improved by throwing the object a little out of focus.

Every part of the spectrum differs a little from adjacent parts in refrangibility, and delicate bands or lines can only be brought out by accurately focussing their own part of the spectrum. This can be done by the milled head B. Disappointment will occur in any attempt at delicate investigation if this direction is not *carefully attended to*.

This spectroscope can be fitted so as to go under the stage of any microscope, but it is probable that it will be little used in this position, as for nearly all experiments the mode described is more convenient. When the spectra of very small objects are to be viewed, powers of from $\frac{1}{2}$ inch to $\frac{1}{20}$th, or higher, may be employed.

Blood, madder, aniline red, permanganate of potash solution (quite fresh) are convenient substances to begin experiments with. Solutions that are too strong are apt to give dark clouds instead of delicate absorption bands.

Mr. Browning makes small cells and other contrivances to hold fluids for examination.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page* 226.)

1518. During the nights preceding April 6, a pale comet was seen above the citadel of Cremona.—(Cavitellius, *Annales Cremonenses*.)

1520. In February, a comet appeared.—(Biot.)

1521. In April, a comet with a short tail appeared in the latter part of Cancer.—(Vicomercatus, Lubienitzki.)

1522. A comet was seen in the W.—(Mizaldi, ii. 11.) No month given.

1523. In July, a comet was seen near *a* Ophiuchi.—(Biot.)

1529. In February a long star traversed the sky. This phenomenon renewed itself in August.—(Biot.) European

writers mention a comet in August, but Pingré considered that their description applied rather to an aurora.

1530. On November 30, a comet was seen.—(Conradus Urspergensis, *Chronicon.*)

1532. A comet appeared in the spring.—(Gaubil.) On March 9, a star with a tail appeared in the S.E.; after nineteen days it disappeared.—(Biot.)

1534. A comet appeared in July.—(Cavitellius *Annales Cremonenses.*) On June 12, a star was seen near π Cygni, κ Andromedæ, etc.; it passed θ Andromedæ, and entering ν, ξ, o, π Cassiopeiæ, disappeared after twenty-four days.—(Biot.)

1536. On March 24, a star was seen near β, γ Draconis; it went eastwards, and passing to the W. of δ, ϵ, π, ζ Draconis, came to the Milky Way, and disappeared on April 27.—(Biot.)

1538. On January 17, P. Apian saw a comet with a tail 30° long, in 5° of Pisces, with a latitude N. of 17°. On the 22nd, Gemma Frisius observed it in 9° of Pisces, with a latitude N. of 11°.—(Pingré, *Comét*, i. 499.)

1539. On April 30, a comet with a tail 3° long was seen. It remained visible for three weeks, and swept α and γ Leonis.—(Biot, etc.) On May 11 (?), Gemma Frisius observed it in 5° of Leo, with a latitude N. of 12°. On May 17, at ten hours in the evening, its position, according to Apian's observation, reduced by Pingré, was 20° of Leo with a latitude S. of 4½°.—(Pingré, i. 500.)

1545. A comet was seen for several days this year. No month is named.—(Aretius, *Brevis Comet. Explicat.*)

1554. On June 23, a comet was seen, which passed from δ to θ Ursæ Majoris. It lasted four weeks.—(Biot.)

1557. In October, the sun being in Libra, a comet was seen in the W. in Sagittarius.—(Camerarius, *Cometæ.*) On October 22, a comet was seen near λ of Limchi. It lasted till the next moon.—(Biot.)

1560. In December, a comet appeared for a month.—(Thuanus, *Historiæ*, xxvii. 11.)

1569. On November 2, a comet was seen in Ophiuchus, and in the signs Sagittarius and Capricornus. Its movement in longitude equalled the extent of these two signs, and it remained visible till November 19.—(Kepler, *de Cometis.*) It lasted from November 2 to November 28.—(Biot)

1578. On February 22, a star as large as the sun appeared.—(Biot.) European writers mention a comet and a hairy star. The latter on April 1, as Tycho Brahe's comet of 1577, remained visible till January 1578. Pingré thinks that this is the object described as the comet of 1578; the hairy star of April he considers to have been a meteor.

1584. On July 1, a star appeared in the division of π Scorpii.—(Biot.)

1591. On April 3, a comet 1° long was seen. It traversed Pegasus and Aries, increasing in length to 2°. On April 13 it entered the division of β Arietis.—(Biot.)

1604. On September 30, a large star, like a ball, appeared in the division of μ^2 Scorpii. It vanished in the S.W. in November. On January 14, 1605, it reappeared in the S.E. About March it became dim.—(Biot.)

1609. A great star appeared in the S.W.—(Biot.)

1618. [ii.] Between November 10 and 26, a comet was seen by Figueroes, at Ispahan, coincidently with the apparition of Comet III. of this year. In consequence of the comet's southerly position, the head was not generally (if at all) seen in Europe; only the tail. Kepler and Blancanus were the chief observers who saw the latter. Kepler *guessed* that on November 10 the nucleus was in 16° of Scorpio, with a latitude S. of 8°, and that on November 20 it was near the head of the Centaur. At Rome the tail was seen to be 40° long on November 18. It was last observed there on the 29th. The observers (Jesuits) note that in eleven days, the proper motion of the tail caused it to pass over 24° from Crater towards *a* Hydræ.—(Pingré, ii. 5.) It may be well to mention here that Mr. Cooper, in his valuable *Cometic Orbits*, p. 77, appears to have fallen into a mistake relative to the comets of this year, which others have copied. He gives the elements of the third comet, and appends notes referring to the second and third, as if they were one and the same object.

1619. In February (?) a comet was seen in the S.E.; it was long.—(Biot.)

1625. From January 26 unto February, a comet was observed by Schickhardt in Hidamus and Cetus.—(*Astronomische Nachrichten*, No. 31, April 1823.)

1639. On October 27, a comet with a small tail was seen in Caius Major, by Placidus De Titis.—(*Ast. Nach.*, No. 171, January, 1830.)

1640. On December 12, a comet was seen.—(Biot.)

1647. On September 29, a comet was seen soon after sunset, in Coma Berenicis. Its longitude was 188°, and its latitude + 26°. It was 12° long, and lasted one week, traversing Boötis N. of Arcturus, to Corona Borealis, in a line sensibly parallel to the equator.—(Hevelius, *Cometographia*, p. 463.)

1699. [ii.] On October 26, Godefroi Kirch observed a faint comet in the poop of Argo, in longitude 122° 34′ and latitude − 40° 38′. It was visible to the naked eye, and its motion was sensibly southwards. Kirch was unable to find it on any subsequent night.—(*Miscell. Berlin*, v. 50.)

PROGRESS OF INVENTION.

PHOTO-PRINTING.—Attempts have been made in various ways to multiply copies of photographs by means of the press; but hitherto the mode in which the various shades are produced by photography have been an insuperable obstacle to complete success. The difficulty, it is probable, has now been overcome, and simultaneously by two persons, by very simple means—the combined use of the principle of carbon printing, and of an ink which, unlike that ordinarily employed, produces a depth of shade dependent on quantity. A glass plate, after having been coated with a mixture of gelatine and sugar, and sensitized with bi-chromate of ammonia, is exposed in the usual way under a negative; after which the gelatine, which has not been rendered insoluble by the action of light, is washed away. A positive picture in relief is thus produced; and a copy of this, in a substance suited to the purpose, is obtained for use in printing. This copy may be made by means of the electrotype process, or by placing a sheet of soft metal over the picture in gelatine, laying both between slabs of cast iron, and subjecting to pressure; or simply by pouring melted sulphur on the gelatine. The electrotype copy is troublesome on account of the mounting required; but as the indentations are deeper it gives better impressions than the plate of soft metal. The copy in sulphur will answer very well in some cases.

To take impressions, ink is made by soaking gelatine in water, then melting it and mixing with it carbon, or even a colouring matter, in very fine powder. If colouring matters are used, they must not be such as are acted upon by the bi-chromate. To take an impression a small quantity of the ink, kept in the fluid state by heat, is poured on the centre of the electrotype, or other copy; a sheet of photographic paper is placed on this, and over the paper a plate of glass; after which, a pressure is applied, that forces the ink into all the hollows, leaving little or none elsewhere. When the ink is cold, it adheres only to the paper, along with which it is entirely removed from the electrotype, especially if, after several impressions have been taken, the plate is slightly greased. All the effects of light and shade are produced by the varying thickness of the ink which has been thus transferred to the paper.

NEW MODE OF FILTERING WATER.—Capillary attraction has been adapted by M. Aman Vigié, to the filtration of water; and as the principle seems easily applicable on the large scale, the method he uses will, most probably, be very generally adopted. While, looking to the sources whence we are obliged to obtain water for domestic purposes, the necessity of filtrating it is universally admitted, the mode of effecting this thoroughly and rapidly is attended with considerable difficulty, on account of the stopping up of the pores of the filter. M. Vigié having observed that when a fluid is raised by means of capillary attraction, the particles of solid matter floating in it do not rise along with it, it occurred to him that this fact, in conjunction with the principle of the syphon, might be applied, even

on the large scale, to the filtration of water—the *modus operandi* being exemplified by the emptying of a bason of water, which most persons have, to their surprise, observed to occur, when a towel hangs down from a bason, etc., of water, in which one corner of it has been accidentally immersed. Capillary attraction in the towel, and the principle of the syphon formed by it, causes the water to be very soon carried over the edge of the bason and poured on the floor. M. Vigié uses, instead of the towel, a porous earthenware, which not being acted on by moisture, is very durable. When the shorter end of the syphon formed of it is placed even in mud, pure water ascends continuously, and the pores remain without being stopped up.

Simple Mode of obtaining Zirconium.—This elementary substance, which has hitherto been procurable only in small quantities, may now be had to any amount, with but little trouble and at a moderate cost, by the method devised by Dr. Phipson. Having discovered that the silicic and boracic acids readily give up their silicon and boron when fused with magnesium, he suspected that zircon might be obtained in the same way, and found on trial that such is the case. The reduction occurs when the magnesium fuses: and, on dissolving out the magnesia which has been formed with hydrochloric acid, zirconium in the form of a velvet black powder is obtained. Titanium may be procured in the same way; but it is worthy of remark that while, during this process, gases are formed with silicium and titanium by combination with hydrogen, such is never the case with boron or zirconium.

Applications of Superphosphate of Lime in the Manufacture of Sugar.—Great loss is experienced in the manufacture of sugar by the change of cane sugar into grape sugar, which is very inferior in sweetening power, is highly hygrometric, and besides is attended by other inconveniences. As, however, its formation depends on the temperature at which the saccharine juice is evaporated, and the time occupied by the evaporation, great saving has been already effected by an attention to these circumstances, and an application of correctives suggested by science. Much, however, still remains to be done, and the loss experienced in the manufacture of maple and sorghum sugars is very great; nor has it been entirely eliminated in the production of cane and beet-root sugars. But it has been found that the waste may be reduced to a *minimum* by the addition of superphosphate of lime to the juice before boiling it.

Economic Production of Methylic Ether.—This ether, which is obtained from methylic alcohol, or wood spirit, has hitherto been obtained by means neither convenient nor safe. M. Tellier, to whose ice machine we have already directed the attention of our readers (No. xlv., p. 230), and who uses it instead of amylic alcohol, has discovered a very simple method of producing it in any required quantity. He forms it by mixing nearly equal quantities of sulphuric acid and methylic alcohol, and causes it to be evolved in the state of vapour by heating to about 120° C., at which temperature—a constant current of wood alcohol being made to flow into the mixture—an uninterrupted emission of gaseous methylic ether

takes place. He uses chiefly two modes of condensing the vapour; in one it is transmitted into alcohol, with which it immediately combines, and it is set free as an oily looking liquid, which floats on the surface by the addition of water, glycerine, or anything else for which the alcohol has a stronger affinity than for the ether. The supernatant methylic ether is obtained separate by drawing off the dilute alcohol, which may be rectified for subsequent use; and it is to be thoroughly dried by the application of fused chloride of calcium, or some other substance having a strong affinity for water. By the second method the ethereal vapour is transmitted into sulphuric acid, which also, if the temperature is kept tolerably low, rapidly dissolves it, forming a solution of methylic ether in sulpho-methylic acid. Heating this to 120° C., ethereal vapour will pass off, but not at a sufficient pressure to produce condensation. To effect this, which, under the circumstances, requires a pressure of about five atmospheres, the vapour given off by the first solution is transmitted into similarly saturated sulpho-methylic acid, which produces a supersaturated solution; and when this is distilled, the resulting vapour, which is large in quantity on account of the richness of the solution, is condensed in vessels strong enough to bear the required pressure,

Decomposition of Sulphurous Acid Gas.—Large quantities of sulphurous acid gas are evolved in certain manufacturing processes: and the escape of these into the atmosphere is not only a waste of valuable materials, but a source of mischief to vegetation, and even to health in the surrounding districts. Many means of preventing, or at least mitigating, this evil have been used; one of the best has been discovered recently, and is founded on the fact that sulphurous acid is decomposed by sulphuretted hydrogen. To decompose the sulphurous acid on the large scale, it is conducted, thoroughly mingled with sulphuretted hydrogen, into a suitable chamber, where the sulphur, in a state of minute division, and fit for many purposes, is deposited; the results of decomposition being sulphur and watery vapour. The sulphuretted hydrogen is obtained by acting on sulphuret of barium with dilute hydrochloric acid; and the chloride of barium which is formed being decomposed with sulphuric acid, the hydrochloric acid is set at liberty, and may be again used for decomposition of sulphuret of barium.

Simple Mode of Obtaining Chlorine.—The ordinary methods of obtaining chlorine by decomposition of hydrochloric acid are attended with certain inconveniences, from which that invented by M. Parmentier is entirely free. He decomposes the acid by dropping into it small quantities of pulverized chlorate of potash, which immediately causes the copious evolution of chlorine, the only residuum being water. This method possesses peculiar advantages when the chlorine is required for the purpose of disinfection; since it may thus be obtained with great rapidity and ease, and its further evolution may at once be prevented, when enough has been evolved, by the interruption of the supply of chlorate of potash, and still more rapidly by the addition of water to the acid.

Substitute for the Steam-hammer.—Nothing has contributed

more to our powers of manufacturing iron and steel, on the large scale, than the invention of the steam-hammer. Without it, in reality, our other improvements in metallurgy would have been deprived of nearly all their value; since the great necessity at the present day in engineering is the forging of enormous masses in a sound and reliable manner, which would be impossible even with the best forms of the old tilt hammer. The steam-hammer has been brought to an extraordinary degree of perfection, but is likely in many instances to be superseded by the still more simple application of the elasticity of the air as a substitute for steam. The atmospheric, like the usual form of steam-hammer, has the mass with which the blow is struck attached to the lower end of a rod, which is fixed to a piston that moves up and down within a cylinder. But instead of this piston being raised and depressed by the introduction of steam below and above it, the cylinder itself is alternately made to ascend and descend, by being connected with a revolving crank. When the cylinder is raised, the air which has been admitted beneath the piston is compressed until its elasticity is sufficient to lift the piston and the hammer attached to it. When the cylinder is depressed, the air above the piston is compressed, and, by its elastic power drives down the piston and hammer with great force and velocity. The piston is prevented from falling, before the elasticity of the air above has begun to act upon it, by the rapidity with which the compressions above and below succeed each other.

Production of Nitride of Iron.—Nitride of iron, which has been ascertained to be the only compound of nitrogen and iron, and is an ammonium in which the whole of the hydrogen is replaced by iron, may be conveniently obtained by passing ammonia over pure protochloride of iron, at a temperature which is just sufficient to drive off in vapour the chloride of ammonium that is produced. The residue is nitride of iron in thin laminæ, or a grey powder. It is decomposed by a high temperature, as also by chlorine, acids, etc. If pulverized, which is easily done, and thrown into the flame of a spirit lamp, it burns with the production of brilliant scintillations. Heated in hydrogen, the nitrogen is driven off, and the softest and purest iron known is left behind.

A New and Powerful Light.—A brilliant light, which answers well for photography, is obtained by M. Carlevaris, by throwing on chloride of magnesium the flame obtained by means of a jet of coal gas, and a mixture of atmospheric air with one-tenth of its volume of oxygen. Fifty litres of coal gas, and about one hundred of atmospheric air, used in this way, per hour, were found to illuminate an immense apartment so thoroughly that it was possible to read with ease in every corner of it.

Miscellaneous.—*The Sewage Plant.*—The nature and habits of this curious plant, which is such an obstacle to the filtration of sewage, have lately been investigated with considerable attention. It makes its appearance in the globular or filamentous form, according to circumstances, and is a species of fungus, of a drab colour, passing into black. Cool weather is more favourable to its produc-

tion than hot; and it varies in size from that of a grain of sand to several inches. It deodorizes the sewage by absorbing the offensive gases; but when broken emits a very disagreeable odour.——*A Harmless Green for Paperhangings*, etc.—The dangerous consequences attending the use in paperhangings of a green colour obtained by means of arsenic, are well known; an excellent substitute for this poisonous substance has been discovered in a compound consisting of three equivalents of barytes and two of manganic acid. It may be prepared by thoroughly mixing three or four parts moistened caustic barytes, two parts nitrate of barytes, and two parts oxide of manganese: fusing the mixture in a crucible heated to dull redness: pulverizing the residual mass, and washing the powder first with boiling and then with cold water, in an atmosphere free from carbonic acid. In this way is obtained a fine emerald green powder, which, under the microscope, is seen to consist of small transparent hexagonal crystals. It is applied to paper by means of thin glue, or the white of an egg.——*Zinnalin.*—This beautiful yellow dye is the final result of the action of nitric acid on aniline or any of the dyes obtained from it. Its reactions are precisely opposite to those of aniline, since it is reddened by alkalies, and changed again to yellow by acids. It may be obtained by adding nitric acid to aniline; a violent reaction takes place, the temperature rises considerably, and a dense yellow vapour, having a very disagreeable odour, is given off. Unless the temperature is kept within certain bounds, instead of the dye being formed, the aniline will be entirely decomposed. The residual liquor, which has a reddish yellow tinge, is to be evaporated in a water bath; and thus a red mass is obtained. When this is pulverized, it greatly resembles cinnabar (in German *zinnober*), and on this account, and from its having been derived from aniline, it has been called *zinnalin*. It imparts to wool or silk a beautiful reddish colour, which is not altered by light or air. It is soluble in alcohol, and still more readily in ether.——*New Method of Hardening Cast Iron.*—Having been raised to a low red heat, it is to be plunged into a liquid containing, for every gallon of water, about two and a quarter pounds of sulphuric acid, and two and a quarter ounces of nitric acid, and kept immersed until it is quite cold. Its surface will then be found, to the depth of more than the one-hundredth of an inch, as hard as tempered steel; and no distortion will have taken place, if it has been plunged as speedily and uniformly as possible into the fluid.——*Screw Float for Paddle Wheels.*—It is well known that a great vibration is produced when the floats of the ordinary paddle wheel enter and leave the water, and that they cause a large and useless expenditure of power, in giving motion to a very considerable body of water. Dr. Croft has invented a float which is in the form of a screw surface, and which, both by experiments with models, and by calculation, has been proved free from these objectionable properties. It remains, however, as yet to be shewn practically that it will take a sufficient hold of the water, and will economise power.——*Waywiser for Cabs, etc.*—Everywhere there

is more or less danger of a dispute between the driver of a hired vehicle and the person who uses it; this is true, even in Paris—though less, perhaps, than in most other places. A driver also may cheat his master, since there is generally but an imperfect check upon him. These inconveniences are likely soon to come to an end, as a very ingenious contrivance has been recently invented at Paris, and is now being tried there, which is expected to put it out of the power of the driver to impose upon either the traveller or his master. It records, in a way distinctly visible, the exact distance traversed, the time consumed in traversing it, the number of stoppages, and the length of each. Also, for the benefit of the master, the number of journeys made in the day, with the time and distance corresponding to them respectively. —— *Production of Magnesium.*—This metal will, very probably, soon become an indispensable requisite, not merely for photography, but for many ordinary purposes. All that is required for this is that its price should become moderate, which it is probable will soon be the case—it has already fallen more than fifty per cent. The cost of this metal, as an illuminating agent, is very easily calculated. A wire of it, the one-thousandth of an inch in diameter, affords a light equal to that of seventy-four Stearine candles of five to the pound. Three feet of this will be burned in a minute—that is, a quarter of an ounce in an hour, which, at the present reduced rate, would cost about two shillings and sixpence. A further reduction, consequent on increased demand and improved methods of production, may be anticipated; but it never can be very cheap as long as sodium is indispensable to obtaining it. There are many purposes to which it will be difficult ever to apply this light, on account of the large quantity of caustic magnesia which is given off as a very fine powder, and which soon renders the atmosphere intolerable. Proper methods of ventilation may, however, in a great degree, remedy this inconvenience. It does not exist in photography, the light is required for such a short time. The magnesium light is not to be considered a perfect substitute for that of the sun, being five hundred and twenty-five times less intense. Its actinic power is the one thirty-sixth of that of the sun. —— *The Capabilities of the Steam-Engine.*—Three Cornish engines have drained the Lake of Haarlem, which contained eight hundred million tons of water, a quantity which would supply London for seven years, and which covered 45,230 acres to an average depth of fourteen feet. These engines, when all the pumps are working, are capable of raising one hundred and nine tons of water ten feet at each stroke.——*Curious Fact in Acoustics.*—If the immense bell, which is in a large chamber at the base of one of the towers of Notre Dame in Paris, is struck with the closed hand, a large volume of sound will be produced, and will be audible to a considerable distance all round; but it has been discovered that it will be perfectly inaudible if the person advances within the bell to the centre, the sound diminishing as he proceeds from the circumference.——*Substitute for Tea, etc.*—It is curious that various portions of the human race have, without being conscious of it,

discovered the means of obtaining the same active principle from very different sources, as theine from tea, caffeine from coffee, etc. This principle undoubtedly produces very important effects on the system, though what precisely these are can only be conjectured. A new source of it has lately been discovered by Dr. John Attfield in the Kola-nut, which is used as an article of food by the natives of Western Central Africa. It is, however, not likely in any way to supersede tea or coffee in these countries. Its taste is not agreeable, and the quantity of theine it contains is very small compared with what is found in tea and coffee. The specimens examined were in the dry state, which may have modified the results.——*Manufacture of Sugar.*—By the ordinary mode of producing sugar from cane juice, a considerable amount of uncrystallizable sugar or fructose, in the shape of molasses, is produced: this may be considered as so much waste. The longer the process of boiling and the higher the temperature, the more fructose, the quantity being, in ordinary cases, so much as twenty per cent. It was found that cane juice, containing only twenty-six per cent,, after an hours' boiling at 250 degrees in a closed vessel, contained fifty-five per cent. This production of uncrystallizable sugar may be avoided by rapid evaporation in an apparatus which has been termed a "concreter," and which consists of a series of very shallow vessels connected together, the evaporation being effected by hot air. The small quantity of fructose originally in the cane juice is not increased during the process, nor the amount of acid. The sugar thus obtained is perfectly dry and solid, and is ready, without further treatment, to be sent over to the refiner; it is said also to be free from that pest, the sugar beetle. The quantity of sugar gained in this way will cause an additional profit of £4 per hogshead. This will ultimately prove, it is hoped, a serious benefit to both producer and consumer.——*Flying Machines.*—The American Government, induced by some experiments made by the late General Mitchell, from which it was concluded that a twenty-foot screw fan revolving with a certain velocity, would lift much more than six tons into the air, has ordered the construction of an aeronautic machine on a large scale. It consists of a cigar-shaped copper canoe, strengthened with iron ribs, and having in the centre an engine capable of driving four screw fans having twenty-foot blades. One of these fans is placed above, and another below the canoe, to produce ascent or descent, and one at each end to effect a progressive or retrograde motion; and the whole, when complete, will weigh, it is expected, only about six tons.——*Wire Cannon.*—A cannon of very peculiar construction has recently been constructed, and the American Government has ordered experiments to be made with reference to it. In forming it, the core is of bronze, which is reduced by the boring to the thickness of only a quarter of an inch. Around this, steel wire is wound tightly to the depth of about an inch, the coils being in a diagonal direction, and those of one layer crossing those of the next at right angles; the whole is then raised to a high temperature and immersed in melted bronze. This mode of construction appears to afford great strength; 500 rounds were fired without the piece being in

the least affected—the charges consisting of one pound of powder, and the projectile weighing seven and three quarter pounds, the bore being two and a half inches. But some slight inconvenience was experienced from the recoil, on account of the lightness of the cannon, which weighs only 167 pounds.

ARCHÆOLOGIA.

During the past summer, and a part of the autumn, extensive researches have been made under the direction of the Rev. William Greenwell, of Durham, well known for his successful antiquarian labours, into the early barrows, or sepulchral mounds in the North of England. These researches have been attended with interesting results, but we can still only look upon these barrows as belonging to a very questionable date, which it will require more facts than are yet known to determine. This year, Mr. Greenwell's labours have been confined chiefly to the neighbourhood of Castle Howard and Malton, the latter place undoubtedly the representative of a Roman town. In general, the barrows opened by Mr. Greenwell present variations in the modes of interment, examples of which were already known in Yorkshire; but altogether they are of so much interest, that we hesitate in attempting any detailed account of them, until, as we trust, the discoverer will give us, as he alone is capable of doing well, his own description of them, with engravings of the objects found. The greater number of these interments were attended with cremation, and accompanied chiefly with urns of rude pottery, and a few wrought flints. The pottery, whether urns or cups, belongs to a type already well known, and in much of which the eye of an antiquary well experienced in Roman antiquities can hardly fail to recognise a rude imitation of Roman forms and ornaments. The most remarkable of these interments was that of a great tumulus on Langton Wold, which separates the Birdsall valley and the chalk wolds from Malton and the Vale of Derwent. This barrow is stated to have contained near the surface a series of Anglo-Saxon interments, underneath which were other important interments, supposed to be British. A few feet from the centre of the barrow, a stone wall was found, formed of flat stones laid edgewise, and in a direction nearly north and south. In digging away the stones of the wall, towards the centre of the tumulus, a skeleton was found, which proved to be that of a very tall man. The body had been laid on its left side, with the knees doubled up. More than one other skeleton was found which had been interred in the same manner. One was that of a female, which was laid on its left side, also with the knees drawn up. The body had been surrounded and covered with stones so as to form a rude cist, and the personal ornaments of the deceased had been buried with her. These were three cowry shells, and extraordinary numbers of the red-striped small snail-shells, one jet bead, three bronze bodkins, part of a belemnite,

ground and polished like a small roller, a bone ornament pierced for hanging or stringing, a large semicircular bone pin, and some other small articles of less importance. Another interment of a female was afterwards found in the same tumulus, similarly placed on its left side. We are inclined to think that these two ladies were anything but, what the newspaper account gives of them, "British Matrons." There are no circumstances in the description of them which are not found in the early Anglo-Saxon—we should say in this case, Anglian interments. The Anglo-Saxons did sometimes lay their dead in the grave on the side with the knees bent up; we have observed it ourselves in more than one instance in the Anglo-Saxon cemeteries of East Kent, and the only body we ever dug up in an Anglian cemetery to the north of the Humber—at Seamer, near Scarborough—was laid on its left side, with the knees doubled up towards the chin, and an unmistakable Saxon knife by its side. Perhaps the Angles of Northumbria buried in this form, when they did not burn their dead. The Angles in Britain practised both modes of interment. Again, the cowry-shell—the oriental cowry, usually—is especially characteristic of Anglo-Saxon graves, and has been found not at all unfrequently in those of Kent. The jet bead, too, the bronze pins, and the objects in bone, are all characteristic of Anglo-Saxon interments. We ourselves have great difficulty in believing in any mixture of Anglo-Saxon with Ante-Roman interments. But this question leaves great room for further investigation, and we look forward with great interest to Mr. Greenwell's promised book, which we are satisfied will be a very valuable contribution to archæological science. T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

THE BRITISH ASSOCIATION.

In the last number of the Intellectual Observer we stated that we should give accounts of such of the more important discoveries brought forward in the different sections as had not been hitherto described in our pages.

One of the most important applications of science illustrated at the last meeting was the mode of converting pig-iron into malleable steel by the Bessemer process. This is performed in instruments termed converters; these are lined with fire clay, and are so constructed that blasts of air can be forced in sixty or seventy streams through the melted pig-iron, which is poured into them. The air is forced in at a pressure of 20 lbs. to the square inch, and is sufficient to overcome the pressure of the melted metal, and prevent its entering the openings through which the air enters. The

air, in passing into the fluid metal, divides itself into innumerable small globules, which pervade the whole of the metal. As atmospheric air contains oxygen, and fluid cast iron contains about four per cent. of carbon, it results that the oxygen of the atmosphere at once unites with the carbon of the iron, producing an intense combustion. By this means a very rapid increase of heat takes place. The iron thus acquires a continual increase of temperature until it arrives at a point hitherto wholly unknown in metallurgical operations. The greatest heat of our furnaces only suffices to render malleable iron sufficiently soft to be indented with the heavy blows of a powerful hammer; but in this process the temperature is so immensely increased beyond that point as to retain the malleable iron in a fluid state. While this increase of temperature has been going on, the large quantity of carbon present in cast-iron, to which it owes its black and brittle character, is removed; and when the whole of the carbon has been thus eliminated from the metal, a known weight of carburet of iron—*i. e.*, pig-iron of a pure quality—is added, so as to restore such an amount of carbon as will constitute steel of the desired quality. The metal, after this admixture, is poured into a casting ladle, and run into moulds. By this means blocks of steel of any desired shape or size are rapidly made. The steel in a heated state can be taken to the rolling-mills or hammers and then fashioned in the ordinary manner.

An interesting paper was read in the chemical section on the action of light on sulphide of lead, having especial reference to the preservation of paintings in picture galleries. Dr. D. S. Price found that white lead pigments were not darkened by sulphuretted hydrogen except where they were shielded from the direct action of light, and he also ascertained that a white painted board that had been exposed to sulphuretted hydrogen until it had acquired a dark brown colour, was bleached in eight days by exposure to light, and that portions covered by opaque objects remained unchanged in colour, and that those parts protected by coloured glasses were protected from the bleaching action of the light in proportion to the opacity of the tint.

Dr. Price also found that the bleaching effect of light or darkened white lead was much more strongly marked when the pigment had been mixed with drying oils, as is the case in oil paintings, and that when employed in water-colours the effect is slower and less decided. In order to show the advantageous effect of light in the preservation of oil paintings, Dr. Price had a picture painted, and then exposed it to the action of sulphuretted hydrogen till it became much discoloured, and apparently destroyed. Strips of dark paper were then secured across the picture so as to cover some parts, and it was exposed to light for a long time. The parts of the picture exposed were perfectly restored to their original appearance, but those protected by the paper remained deeply discoloured and obliterated.

From these experiments Dr. Price came to the conclusion that it is most advantageous to have picture galleries well lighted, especially in towns were the air is charged with sulphur compounds, and that

it was quite a mistake to hang curtains in front of pictures with a view to their protection.

Mr. Pengelly made some very interesting observations on the insulation of St. Michael's Mount, Cornwall, which is now an island at high tide, and a peninsula at low water. The early British name of the mount signifies the "hoar rock in the wood," a description that is no longer applicable; but the change must have taken place before the time of Diodorus Siculus, who wrote 9 B.C., as he described the mount as it exists at present. Mr. Pengelly rejected the theory that the rock had been insulated by the encroachment of the sea, and maintained that its present condition was due to a general subsidence of the land. In the observations which followed the reading of the paper, Sir Charles Lyell supported the views of Mr. Pengelly, and said that there had been considerable changes of level since the ancient workers in tin had carried on their labours. There had certainly been a submergence and deposit, and then a re-elevation of many parts of the country since that time, and that the proof of this was highly interesting as showing that great changes had been effected in the condition of the globe during the human period.

Among the improvements in practical science brought forward at the Association, may be described the utilization of blast furnace slag as practised in France and Belgium. The plan there pursued is to run the slag direct from the furnaces into a pit eight or nine feet in diameter, and three feet in depth; in these it is allowed to cool slowly, which requires eight or nine days, when the solid mass is removed and cut into slabs of the required size for paving stones, for which purpose it is used in many of the towns of France and Belgium, and some of the streets of Paris, and is found to be superior to the sandstones and grits usually employed in those countries where there is a great deficiency of good paving stones. Whether the plan would answer conveniently in this country remains to be proved, as we possess a greater supply of good stones, and the space required for the pits would be a serious drawback to the introduction of the process, and there is much difference in the slags from different furnaces.

The unstable equilibrium of the elements of gun-cotton was strikingly shown by some experiments detailed by Mr. Scott, who found that either of the metals, potassium or sodium, produced an immediate explosion of this substance even when in a perfectly anhydrous condition, none of the other metals appeared to possess the same power as those of the alkalies, and even an amalgam of potassium or sodium is inert. The singular result of the contact of potassium or sodium with the cotton appears due to direct chemical action, and not to the presence of water or moisture inflaming the metal. It may be stated that gun-cotton is now being manufactured for use in ordinary breech loaders by Messrs. Prentice, and is found to be perfectly safe and to possess a higher penetrating power, and to cause much less recoil than common gunpowder.

ENTOMOLOGICAL SOCIETY.—*Oct.* 2.

Fossil Insect in the Devonian Strata of North America.—At the last meeting of the Society Mr. Samuel Scudder, Secretary of the Natural History Society of Boston, U.S., exhibited fossil impressions of a gigantic *Ephemera*, which must have measured five inches across the full expanse of the wings; these impressions along with others had been found in the Devonian strata of North America, and were the earliest known records of insect life on the globe.

NOTES AND MEMORANDA.

Vegetable Transformations.—M. Trécul has a paper in *Comptes Rendus*, detailing experiments and observations which he thinks shew that the organic matter contained in certain plant cells can transform itself, during putrefaction, into living bodies, differing from the species generating them. He tells us that in the bark of the elder (*Sambucus niger*), and in plants of the Solanum and Crassula families, there are to be found utricles full of little tetrahedrons, containing amylaceous matter, and that he has seen these bodies elongate themselves by one of their angles, and gradually form a peculiar plant by producing a cylindrical stem.

The Spiral Vessels of Plants.—M. Lertiboudois states, in *Comptes Rendus*, that the spiral or tracheal vessels of plants may not only contain air, but be traversed by fluids capable of solidification. In one instance he found the large vessel in the centre of fibres of the *Calamus Rotang* full of a white solid substance, composed of cylinders of variable length. Placed in water this material resolved itself into granules, which exhibited a lively motion.

Pharaoh's Serpents.—The amusing chemical playthings, lately introduced and so named, are said to be composed of sulpho-cyanide of mercury, and their peculiarity consists in the extraordinary volume of ash which they pour forth in a serpentine form, as soon as they are ignited. They are highly poisonous, and it would be unadvisable to allow the air of a sitting room to become too full of their fumes. Cyanogen, or "blue producer," as the name implies, is an essential constituent of Prussian blue. It is a compound of carbon and nitrogen, in the proportion of twelve by weight of the former to fourteen of the latter. At ordinary pressure, cyanagen is a transparent gas; under a pressure of four atmospheres a liquid, and may be frozen at $-30°$ into a crystalline solid. It forms a series of important compounds—that with hydrogen is hydrocyanic, or prussic acid. With sulphur it forms sulpho-cyanogen, the compounds of which are called sulpho-cyanides,

The Moon Eclipse, 4th Oct.—In Paris, according to Messrs. Goldschmidt and Flammarion, this eclipse was very well seen, and the radiating lines from Tycho and other mountains in the obscured parts were distinctly visible, as were also the margins of the various craters. In the neighbourhood of London the same facts were noticeable, and the copper-coloured light on the eclipsed portion was unusually striking, from the extreme fineness of the weather. It looked as if a cap of dark but luminous copper-coloured smoke was slowly drawn over part of the moon's face. The refractive power of the earth's atmosphere is said to be the cause of this phenomenon.

The Magnetic Storm in August.—The great magnetic storm, which began on the 3rd August, commenced very suddenly, and was felt simultaneously at Kew and Lisbon. The needle was violently agitated. The storm, after a period of repose on the second day, broke out again. In general character it resembled the magnetic storm of 1839, and on both occasions the sun exhibited large spots rapidly changing their appearance.

London from a Balloon.—In Mr. Glaisher's October ascent, the long lines of gaslit streets produced a very splendid effect, like a brilliant milky way, but more golden. The reflection of the gaslights from the clean pavement of Regent Street had the appearance of a glistening silver band. Observations of this class may assist us in interpreting some of the telescopic appearances of the moon, as regards their luminosity and colour.

A Magnesium Battery.—M. Bultinck, of Ostend, describes to the French Academy, experiments which he made, substituting magnesium for zinc, in a voltaic combination. A chain of twenty elements, combined like those of Pulvermacher, gave striking effects when simply moistened with water.

Animal Grafts.—M. P. Bert gives to the French Academy further accounts of his remarkable animal grafts, such as making the tail of a rat grow on another creature. The end of the tail is skinned and introduced in the subcutaneous tissue. An effusion of plastic fluid takes place, and fibres soon appear. On the fourth or fifth day, capillary vessels have united the vessels of the graft and the creature in which it is placed. At a later period these vessels became larger. In the course of twenty days, the muscular fibres experience fatty degeneration. The nerves exhibit a double process of degeneration and regeneration. The bony and cartilaginous parts undergo little change. If the tail is a young one it completes its growth in its new position, and may even surpass the dimensions it would have normally reached.

Clarification of Water.—Mr. Jennet states that in the well known plan of clarifying muddy water by the use of alum, that the alum doubles itself into sulphate of potash, which is found in the clear water, and into sulphate of alumina, which exerts the clarifying action as it decomposes, its earthy base forming an insoluble precipitate which drags down with it the mechanical impurities. Sulphate of alumina is equally useful as alum (sulphate of alumina and potash), and in smaller quantities. Alum being used in the proportion of four-tenths of a gramme to a litre, and sulphate of alumina as a substitute for alum in the proportion of seven to ten.

The Long-Eared Bat.—Mr. Sowerby, writing in the *Annals of Natural History*, describes how one of these animals, confined in a wire gauze cage, captured his prey. The wing membrane extends from the hind legs to the tail, "forming a large bag or net, not unlike two segments of an umbrella, the legs and tail being the ribs." To catch a large fly the bat threw his body on it, drove it into this bag, and devoured the fly at leisure.

The Water Shrew.—Mr. N. L. Austen describes in the *Annals of Natural History* the habits of a pair of water shrews, which he kept in a large cage, like a dormouse cage, with a bath in it. They did not appear timid, and readily ate their food. When minnows were put in the bath, they plunged in after them, each securing a victim, which he killed by biting through the head. In feeding they held the fish firmly between their fore paws, as an otter does. The ears of shrews are furnished with three valves, which fold together when they dive, and keep the water out.

Variations of Human Muscles.—Mr. John Wood describes in the *Proceedings of the Royal Society*, No. 77, cases of variations in human myology observed during the dissection of thirty-six subjects in King's College Hospital. The paper is too technical for its details to be understood by any but those acquainted with anatomy; but it establishes two interesting facts—first, that important variations from the normal type do occur, and, secondly, that in some cases they exhibit characteristics found in monkeys, bats, moles, birds, and sloths.

85th Planet.—Dr. Peters, of Clinton, U.S., has discovered another planet, 10 mag. At the end of September its position was R. A. 12° 43′ 5′ 3, D. + 11° 22′ 5″ 9.